MACHINERY.

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THE HINDLEY WORM AND GEAR.

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THIS article, on the subject of the Hindley worm and gear, was prompted by an editorial (February, 1908) asking for data, and by certain hazy ideas that seem to prevail regarding the nature of contact between the thread and teeth.

This type of worm gear was first used in Hindley's dividing engine, and was by him considered superior to the ordinary type, in wearing quality. Investigation has practically settled that the nature of contact between the worm thread and the teeth of the ordinary worm-wheel is that of line contact, extending across the tooth on the pitch line. It has also been fairly well proved in practical examples that the contact is of a broader nature on account of the elasticity of the materials used in the construction. The convex surfaces of contact are flattened considerably under pressure and thus for practical purposes make actual surface contact. The contact in the ordinary worm and worm-wheel type is limited to two teeth of the wheel and worm thread at most.

Comparison of Ordinary and Hindley Worm Gearing.

The conditions are much different in the case of the Hindley worm, and it is the intention in this article to show wherein the difference lies. As this style of gearing is uncom-

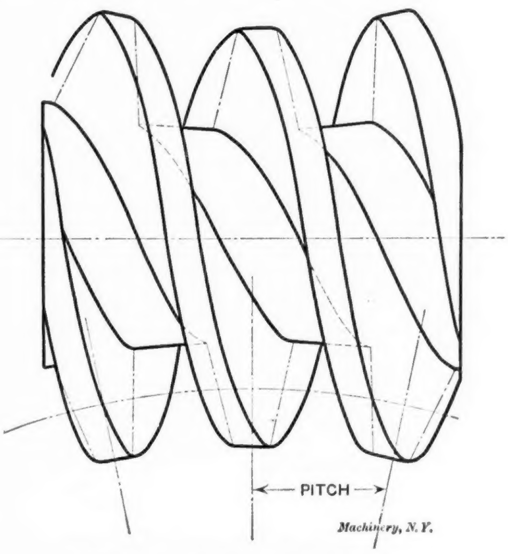

Fig. 1. The Typical Hindley Worm.

mon to most of us, a few words regarding its construction will not be out of place. Fig. 1 is a sketch of the Hindley worm, showing the theoretical form. This worm is not of cylindrical shape, but is formed somewhat like an hour-glass, after which it is sometimes named. The worm blank being made smaller in diameter in the middle than at either end, conforms to the circumference of the wheel with which it meshes. The worm thread is cut by a tool which has motion in a circular path about a center identical with the axis of the wheel with which it is to mesh, and in the plane in which the axis of the worm lies. The process is similar to ordinary thread cutting in the engine lathe, except for the difference in the path of the tool, the tool having a circular instead of a straight path.

It is evident that the worm shape is dependent on the particular wheel with which it is to run, and Hindley worms are not interchangeable with any other but an exact duplicate. That is, a worm cut for a Hindley gear of 50 teeth cannot be used successfully with a wheel of 70 teeth, although the pitch of the tooth is exactly the same. In the ordinary type of worm gearing, one worm may be made to run with any number of diameters of wheels of the same pitch, and hobbed with the same hob.

In action the two styles of worm gear differ greatly and both diverge widely in action from the case of a plain nut and screw, which may be taken to represent a worm and worm gear, the latter of infinite diameter and with an angle of embrace of 360 degrees. In studying the action between the thread and teeth of the ordinary type of worm gear, we must comprehend odontics, rolling contacts and the theory of tooth gearing, in general, in order to understand the action

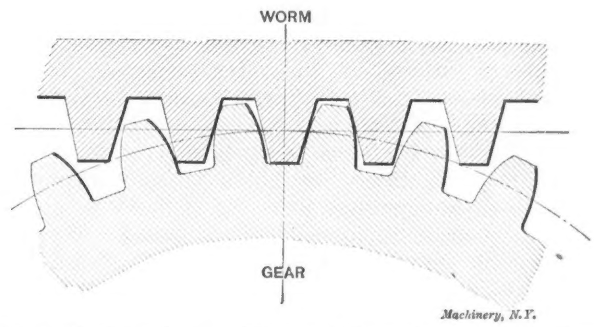

Fig. 2. Section of Common Worm and Worm-wheel on Middle Plane.

of the ordinary worm gear. But, in studying the action of the Hindley type, we are concerned with no such theories, as the action is purely sliding and devoid of rolling contact. In the ordinary worm we have an axial pitch which is constant from top to root of the thread, while in the Hindley worm we have a section in which the pitch of the thread varies from top to bottom.

Interference as found in the ordinary type of worm gear is absent from the Hindley, and the consequent undercutting and weakening of the teeth, therefore, is a feature with which the designer of the Hindley worm gearing does not have to contend. For this reason we are not limited in the length of teeth, by interference, as in the ordinary case. This fact permits the wide latitude in the choice of tooth shape and proportions. In most examples we will find that the

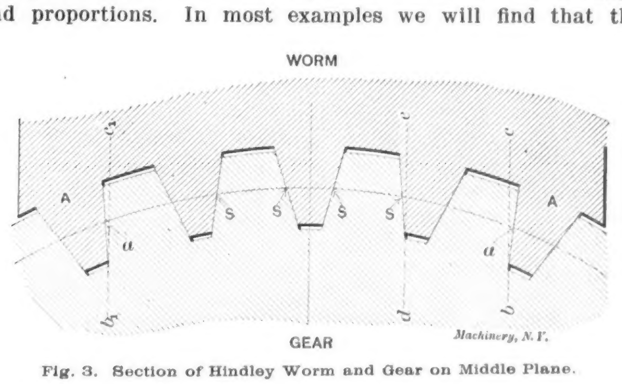

Fig. 3. Section of Hindley Worm and Gear on Middle Plane.

depth of thread is much greater in proportion to the thickness than in the ordinary worm gear in which the height is limited by reason of the interference at the top and root of the teeth.

Nature of Contact of Hindley Worm Gearing.

The general idea of the Hindley worm gearing is that there is surface contact between the worm and gear, and that the contact is generally over the whole number of teeth in mesh. If such were the actual conditions, the Hindley type would surely be an ideal mechanism for high velocity ratios, but that such is not the fact is the purpose of this article to point out. That the contact is of a superior nature we will not deny, nor that it is much nearer a surface contact than exists in the ordinary worm gear. As a means of comparison,

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Figs. 2 and 3 are shown. Fig. 2 shows an axial section taken through the worm and gear of the ordinary type, while Fig. 3 shows a similar section through the Hindley worm and gear. The "airy" appearance of Fig. 2 as compared with Fig. 3, indicates a vast difference in the nature of contact, and gives the advantage to the Hindley type, wherein is the origin of certain false ideas in favor of the latter. These illustrations also show peculiar differences in the action of the two types. The absence of rolling action in Fig. 3 is the most prominent, and it shows the similarity between this type of gear and a screw and nut.

From an inspection of Fig. 3 we may feel sure that the contact on the axial plane is as shown, but as to the nature of contact in a plane either side of the middle plane we are

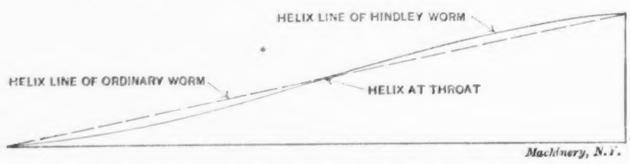

Fig. 4. Development of Ordinary Worm and Hindley Worm Spirals on a Plane.

in the dark so far as the drawing illustrates. Mr. George P. Grant has this to say concerning the contact of the Hindley worm and gear: "It is commonly but erroneously stated that the worm (Hindley) fits and fills its gear on the axial section. . . . It has even been stated that the contact is between surfaces, the worm filling the whole gear tooth. . . . It is also certain that it (the contact) is on the normal and not on the axial section, and that the Hindley hob will not cut a tooth that will fill any section of it. The contact may be linear on some line of no great length, but it is probably a point contact on the normal section."

It is not clear what reason Mr. Grant had for saying that the contact is normal instead of axial; but there is every reason to believe that the contact is on the axial section since it is on this section that the teeth of the hob have a common pitch. The teeth have not a common pitch on any section at an angle with the axial section. For what reason would one expect to find contact on the normal section in this case any more than in the case of the ordinary worm? Since both styles of worm-wheels are hobbed with a revolving hob which lies in a plane perpendicular to the axis of the worm-wheel, the contact could hardly be on a normal section.

Prof. MacCord states that he considers the contact to be line contact on the axial section, and he gives directions for

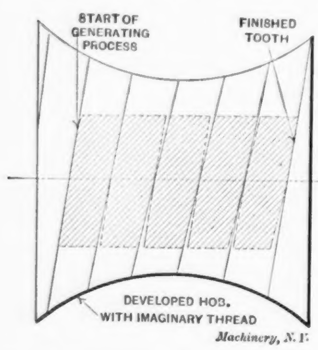

Fig. 5. Successive Steps in Shaping Hindley Worm.

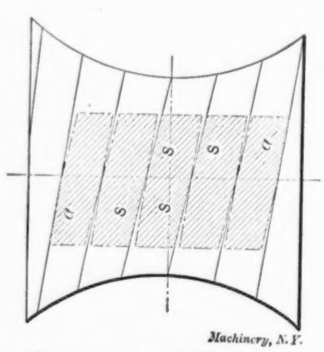

Fig. 6. Surfaces of Contact of Hindley Worm.

obtaining the exact nature of the contact and also the thread and tooth sections. These directions, on account of the complicated nature of the method, are hard to follow. Much, however, can be found out by simple methods. In what follows, describing these simpler methods, the results, of course, are of an approximate order, but they nevertheless give a means of comparison and a material basis for the line of argument.

The Ideal Case Considered.

It is assumed that we are examining an ideal Hindley gear in which the worm and wheel are theoretically correct in shape and that the surfaces are perfectly smooth and inelastic. From the nature of the worm, the helix angle varies from mid-section to the ends, decreasing as the thread approaches the ends of the worm. The thread is spiral as well as helical. This change in the thread angle is caused by the increase in diameter at the ends of the worm and by the fact that the axial pitch of the thread decreases as it reaches the ends. The decrease in axial pitch is due, of course, to the circular path of the threading tool. If we take a development on a flat surface of a line scribed in the spiral path on the worm blank, as shown in Fig. 4, the change in the angle becomes noticeable.

In the operation of forming the teeth of the gear, the blank is rotated, each portion of the hob working the tooth into shape so that it will pass the corresponding portion of the worm thread without interference, permitting a smooth transmission of motion. If each portion has a different shape or is placed in a different relation, the shape of a gear tooth will be a compromise between the extremes, and this is what is actually the result, as we shall see later.

The progressive steps of the process are shown in Fig. 5; the successive positions of one tooth are shown, beginning at the left and ending at the right-hand position where each tooth is given its final shape. The nature of the process is shown in Fig. 6, the shaded portions representing the gear teeth. Here we have a representation of the contact of the thread and teeth; it shows that surface contact is impossible on any but the heavily shaded portions of the teeth, it being confined to the mid-section and the extreme end sections of

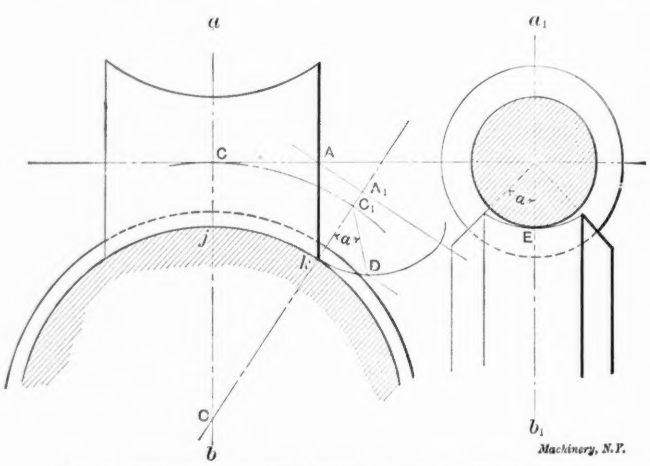

Fig. 7. Effect of Hour-glass Shape on Worm-wheel Contact.

the worm. Line contact is obtained throughout the length of the worm on the axial plane. This figure also shows that no advantage is gained in surface contact by making the worm of greater length. The location of the contacts are shown in Fig. 6 at *a*, *s*, *s*, *s*, *s*, *a*, but it must be remembered that they lie on opposite sides of the cutting plane. From this it is apparent that the worm does not entirely fill the space between the teeth of the gear and that the contact is not wholly a surface contact.

Let us investigate still further and see whether the conditions are not modified by other irregularities: Fig. 7 is drawn to represent a worm and gear of the Hindley type, in mesh, the teeth of which have no depth. As before mentioned, the peculiarity of this type of worm is its hour-glass shape. The hob and worm may be treated as identical in form. In the process of generation, the tooth has a pitch line curvature that changes with corresponding positions in relation to the thread portion acting upon it. The tooth must necessarily be modified from what it should be for any particular location in its contact with the worm thread. It is quite clearly shown that if the tooth is to fill the worm thread or *vice versa*, it must be formed in strict accordance with the thread at that particular point. Thus if at j the tooth fills the thread, that tooth must be formed by the thread at that point, while the tooth at k must be formed by the thread at k. Now, since each tooth must pass from k to j, its form must be such that it will do so without interference. It is evident that the radial section of the gear at k must be the same as at j. Since the worm is largest in diameter at k, the curvature of the tooth on the radial section is dependent on the thread at that point. The curvature of the tooth at k evidently is that of an ellipse whose major axis is $A A_1$. Now, since the thread is made with angular sides, the hob could

hardly act on the teeth of the gear the same at all points from k to j except on the axial plane where the relative shape of the hob thread is the same for any position along the line of action (see Fig. 3). This is evident from Fig. 7 at E, which point only touches at the mid-section of the worm. Therefore we still have the line contact from top to bottom of teeth on the axial plane, but the construction, Fig. 7, shows that the surface contact s, s, s, s, Figs. 3 and 6, does not actually exist, but that the surface contact at the ends of the worm remains undisturbed.

From the above we may safely conclude that the hob at j has but little effect on the actual shape of the tooth, and

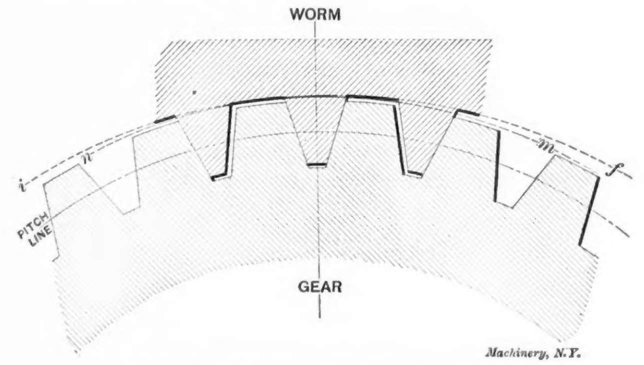

Fig. 8. Effect of the "Second Cut" on Contact.

that its influence increases until k is reached. Fig. 7 also shows a good reason why the contact may be considered axial instead of normal, by the mere fact of the differences in curvature of worm and wheel at any point other than k. In practice the contact may appear to be surface contact, but this, no doubt, is due to the influence of the lubricating oil and the fact that materials of construction are distorted to some extent in form when subjected to pressure. This distortion permits the worm thread to imbed itself into the worm-wheel teeth, somewhat broadening the contact for the time being. The conditions as stated in the above discussion, would be met in the case of a hardened worm and gear with surfaces finished by lapping. In practice the worm and gear are ground together, sand and water being used as the abrasive. This grinding wears down the roughness of the surfaces and tends to correct irregularities in fdrm that develop in the hobbing process.

Objections to the Hindley Gear.

The objections to the Hindley type of worm gear are many and are widely known. It must be set up accurately, the alignment being made perfect. End play is a feature that must be avoided, as any longitudinal displacement of the worm will cause the gear to cut. These peculiarities are the greatest drawbacks to the use of this gear and because of them I feel that it will not come into common use, at least not so common as the worm drive of the ordinary type. This feeling is strengthened by the fact that we have become so much more familiar with the latter type as to be able to design and construct drives that work satisfactorily in every respect.

Modifications of Hindley Worm Gear Practice.

Some modifications have been made in the process of manufacturing the Hindley worm gear. One that is probably of first importance is that known as the "second cut," this practice being generally credited to Mr. Albro of Philadelphia, but the credit for it is in dispute. The effect of the second cut is indicated in Fig. 8. From this sketch one would be likely to say that the part of the second cut was to remove the points of contact. Whether this is the reason or not, it is a fact that it does remove considerable of the contact from all but the mid-section of the worm. This second cut is made by enlarging the diameter of the circle in which the threading tool travels when cutting the worm. It is said to have advantages that add to the wearing quality of the drive, but just what these advantages are is not apparent, and since the process is considered more or less a trade secret, it is difficult to obtain authentic reasons for its use. The second cut is mentioned here in the hope that someone knowing the reason for its use may respond with a full account. This he may be sure will be appreciated generally by the readers of MACHINERY.

The limiting length of the worm is dependent on the shape of the thread. In Fig. 8 the worm is shown with three sections in mesh, while Fig. 3 shows five. Fig. 3 shows a case that would be impossible in practice on account of the undercut sections A which lock the worm in mesh. The side of the thread must fall inside the line bc to permit the worm and gear to be assembled. Following are the conclusions which I derived from my investigation regarding the Hindley type of gear:

1. The contact is purely sliding contact.
2. The nature of the contact is linear, closely resembling surface contact.
3. Linear contact extends from the top to the root of the tooth.
4. The contact is on the axial section.
5. The thread section fills the tooth space on the axial section only.
6. The mid-portion of the hob has little or no effect in shaping the teeth of the gear.
7. Surface contact exists on opposite sides of the axial plane at the end of the worm thread and is intermittent in nature, because the end of the thread passes out of contact with the tooth in the revolving of the worm. This contact is on a plane normal with the thread angle.

In practice it is usual to allow considerable back-lash between the thread and the tooth of the worm and gear. This play tends to counteract bad workmanship, either in construction or erection.

[The foregoing article is, we think, a sound and unprejudiced exposition of the theoretical Hindley worm gear, but should be regarded as not applying strictly to this type of worm gearing as actually manufactured. The commercial Hindley gear differs considerably from the ideal form, as intimated by Mr. Edgar in the part where he speaks of the "second cut" process, but this difference is not all. The shape produced in the manufactured gear so differs from the theoretical type that comparison really is unfair. The "grinding in" of the worm and gear with sand and water or powdered glass and water, has much more significance than is ordinarily given it by those unfamiliar with the process. It is more than a mere smoothing process, it being claimed that it actually shapes the worm teeth to a form that cannot be duplicated with a cutting tool by any known process. It appears also that there is a misconception about the rigid requirements of location of the worm and its gear. Hindley worm gears have been made, and are in successful use, in which considerable longitudinal motion of the worm was provided for on account of the need for such motion; and from an investigation of the manufacture, we are inclined to believe that the matter of location in other planes is not much more important than with the ordinary worm gear type, notwithstanding a previously expressed opinion to the contrary.—EDITOR.]

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Various writers on the work of wood seasoning have called attention to the merits of lumber sawed from logs long submerged. They do this by speaking of the distinct advantages gained by soaking the logs or the sawed lumber in water as a preliminary step to the air seasoning. It is pointed out that in Japan logs are kept in brackish ponds for several years before being worked up. To this treatment is ascribed the peculiar freedom from warping found in woodwork from Japan, and especially in the wood carvings which are common in that country. The warping of woodwork is due to a change in dimension caused by the wood adjusting itself to the moisture condition of the surrounding air. In damp air wood swells, but shrinks as the air becomes drier. This property of wood can not be overcome entirely, but the search continues for methods of reducing it and retarding it so as to lessen its damage. Soaking does decrease the tendency to warp, but by no means overcomes it entirely. The effect of soaking as a remedy for warping, however, is less than can reasonably be expected from some methods of steaming. As a commercial practice the soaking of logs or lumber to remedy warping of the finished product is not to be recommended, except when it can be done during storage or transportation, because of the time required to produce results that fall far short of what is usually claimed.

AEROPLANE-TYPE FLYING MACHINES.

A REVIEW OF WHAT HAS BEEN ACCOMPLISHED TOWARD HUMAN FLIGHT.

HARRY WILKIN PERRY.*

Nineteen-hundred-and-eight will undoubtedly go down in history as the year of the actual accomplishment of human flight. Many successful flights were made by experimenters before this year, and the Wright brothers really flew for thirty-eight minutes in one trial near their home in Dayton, Ohio, as long ago as October, 1905, but the fall of the present year appears to have been the culminating period for the public demonstration of man's mastery of the unstable atmosphere. The skeptical world is convinced at last that the dawn of a new era in transportation has arrived and that it is only a question of manufacturing activity and practice under competent instruction, for the time to come when many men will be doing all that a very few are doing to-day—and more. Even as this is written, lessons in operation of the aeroplane are being given to army officers and others in France by Wilbur Wright, and the pupils unanimously assert that the operation is extremely simple and can be learned in a few lessons. Contracts have been signed for the sale of the French patents held by Wilbur and Orville Wright, and for the manufacture of fifty machines on the same model as the ones that have been so successfully demonstrated at Le Mans in France and at Fort Myer in Virginia. So it appears that the long era of experimentation is finally drawing to a close and the commercial period of actual manufacture and use of flying machines is about to begin.

While all credit must be freely given to the Wright brothers for their success, and particularly for the improvements they have devised for controlling the movements of their aeroplanes, the fact is not to be lost sight of that in principle, form and construction their machines follow closely the gliding machines used experimentally many years ago by Octave Chanute and A. M. Herring, and that many of the laws of aerostatics and aviation were worked out by Prof. S. P. Langley through a long series of experiments, and by Lilienthal, Pilcher and Maxim. The only types of heavier-than-air machines that have been developed to a stage where they can be called successful are those that follow closely the forms originated by these pioneer investigators. These are the so-called biplanes, having fixed wings arranged in two parallel planes one above the other, or monoplanes, having a series of supporting surfaces disposed in approximately the same horizontal plane. Because they have given only slight promise of success, it is possible to eliminate from consideration the machines that come within the classification of helicopters (from the Greek words meaning spiral and wing), in which the weight is lifted by two or more propellers revolving in a nearly horizontal plane; and also those known as ornithopters (meaning bird wing), which are designed to fly by reason of a mechanical simulation of the motion of birds' wings. We can also pass by the tetrahedral and a variety of other curious forms with which experiments have been made.

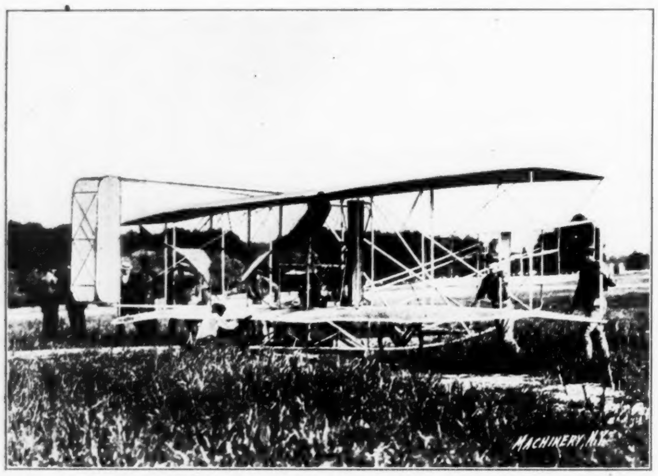

Fig. 1. Orville Wright's Aeroplane at Fort Myer, Va. Soldiers placing Machine on Rail preparatory to Launching.

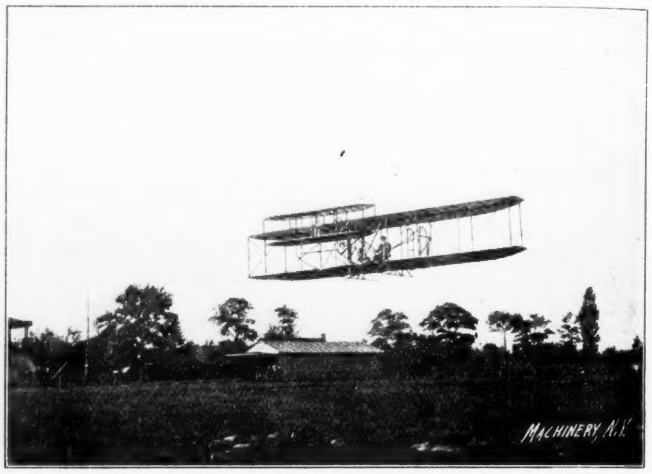

Fig. 2. Wilbur Wright's Aeroplane in Flight at Le Mans, France, August, 1908.

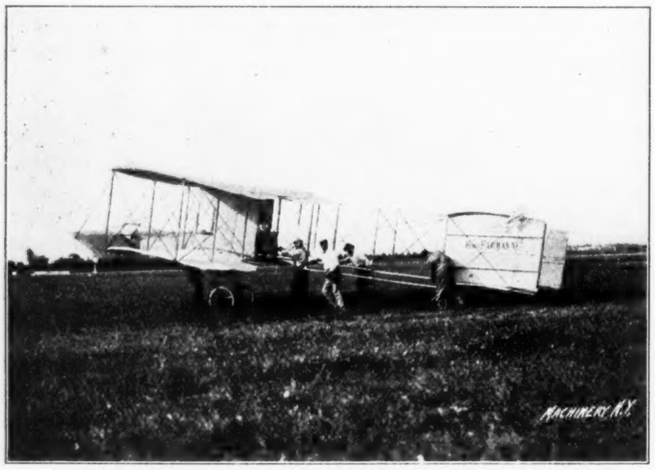

Fig. 3. Henry Farman's Aeroplane at Brighton Beach Race Track, Coney Island, N. Y., August, 1908.

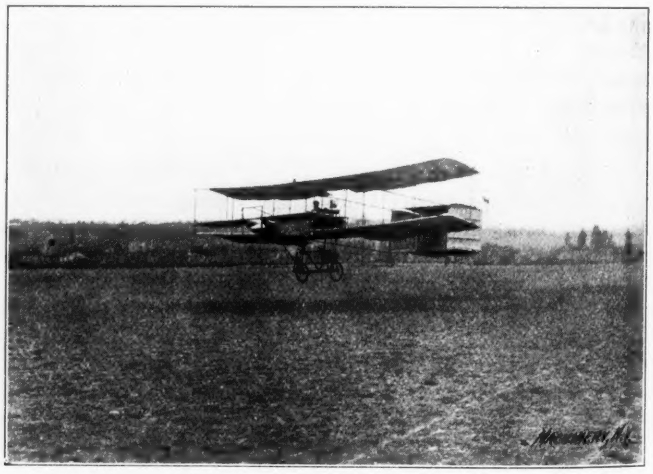

Fig. 4. Farman's Aeroplane in Flight at Issy-les-Moulineaux, France.

It is needless here to recount the long series of successful flights by Wilbur Wright in France and his brother Orville at Fort Myer during August, September and October of this year. These are common knowledge, and the deplorable accident at Fort Myer on September 17, which resulted in the death of Lieut. Thomas E. Selfridge and the serious injury of Orville Wright, from which he only recovered sufficiently to leave the hospital on October 31, in nowise detracts from the convincing demonstrations that have been given. Only four days after the accident to his brother, Wilbur Wright broke all records by a flight of 1 hour 31 minutes 20 seconds, during which he covered a distance of 60.85 miles, flying in an elliptical course over the military grounds at Auvours, his elevation varying at will from 25 to 80 feet. He was awarded the gold medal offered as a prize by the Aero Club of France for the flight of longest duration made before October 1, 1908. Subsequently he again broke all records by flying for 1 hour 4 minutes 26 1-5 seconds with one

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passenger aboard, on October 6, thus fulfilling the conditions of the $100,000 contract entered into with Lazarre Weiller for the French patent rights, and proving his ability to meet the requirements of the United States government contract to fly for one hour with a passenger. He has flown in winds up to eighteen miles an hour and remained aloft for more than an hour in gusty and uncertain winds, part of the time after dark. Remarkable mastery of the machine has been shown in turning, in ascending and descending, in righting the machine after a sudden gust of wind, in meeting unexpected emergencies and in alighting without perceptible jar.

The general appearance and construction of the Wright biplane are well shown in Figs. 1 and 2. The "wings" or main supporting surfaces measure 40 feet from end to end by 6½ feet wide, affording nearly 520 square feet. They are made of muslin cut on the bias and stretched over wood ribs that give a concave form to the under side of the "planes"—

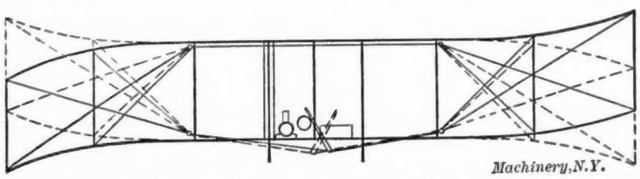

Fig. 5. Diagram Illustrating Method of Twisting the Wings of the Wright Aeroplane. Dotted Lines Indicate Alternating Positions of Wing Ends, and Operating Wires.

a form that hundreds of experiments have shown to give the best lifting effect and greatest stability. A pair of long, stout spruce runners carry the weight when resting on the ground and serve to alight upon when the aeroplane comes to earth. These runners project forward and curve upwardly to provide support for the front horizontal rudder which is of biplane form and hinged along a longitudinal axis. The front edges of the main planes are made stiff and rigid, the 40-foot wood strips being spaced apart by 6-foot vertical wood bars and stayed by piano wires stretched taut diagonally from corner to corner in both directions, in cantilever manner. But unlike other biplanes, the rear edges and corners of the wings are purposely left flexible. The vertical bars are connected by flexible joints with longitudinal strips placed to the rear of the center line, and to the upper and lower rear corners are attached small steel cables that pass diagonally downward and upward to pulleys secured to the rigid part of the frame and thence to one of the operating levers in front of the aviator's seat.

This construction, it should be noted, is of first importance in the manipulation of the aeroplane and forms the subject of all claims in the patents issued in the United States and France to the Wrights on May 22, 1903, and January 27, 1908, respectively. In the words of the patent, the object is "to provide means for maintaining or restoring the equilibrium or lateral balance of the apparatus." The four rear corners, Fig. 5, are so connected together and to the control lever that a sidewise movement of the lever draws downward the two rear corners of the wings or planes on one side and raises the corresponding corners on the opposite side to the same degree. This gives a helicoidal twist to the planes, causing them to present varying angles of incidence to the air, and tending to elevate the side of the machine on which the wings are twisted upward. The degree of twisting can be regulated to a nicety by the operator, enabling him exactly to counteract the effect of all air movements. In order to secure the desired effect, however, it was necessary to arrange a vertical rudder to act in conjunction with the wings and hold the machine to its course; otherwise it was found that instead of rising as intended, the wing presenting the greater angle of incidence would be retarded and would drop, while the opposite wing, presenting diminished resistance, would shoot ahead and rise, the machine being swung sharply out of its path. This, in fact, is what occurs when the aviator wishes to make a turn. Before reaching the turning point, he moves the lever to deflect the corners and rear edges of the planes, so that the ends of the wings on the inside of the turn drop, and those on the outside rise, canting the whole machine at a decided angle before the vertical rudder is moved to make the turn. Thus, the aeroplane has a bank of air against which to make its turning movement and does not slide sidewise, just as an automobile does not skid at high speed on the turn of a sufficiently banked track.

The Wright aeroplanes and their success have dispelled some illusions that have been held almost universally up to the present time. The most important of these is the belief that the weight of the machine and that of the engine must be cut down almost to the irreducible minimum and the power increased to the maximum. Beside the admirable workmanship of the best foreign aeroplanes and aeronautical engines, the Wright productions seem crude and unworkmanlike. The framing of the machines is heavy and almost roughly finished, and the engine looks more like an ordinary marine motor than one designed and built solely for use on a flight machine for navigating so light and unstable an element as the atmosphere. The whole aeroplane weighs 800 pounds without operator aboard, which, it is true, is some 200 pounds less than the Delagrange and Farman machines weigh with their wheeled attachment for starting and alighting, but Wilbur Wright has flown for periods of four and seven minutes with passengers aboard weighing 200 pounds and more, and he has attained speeds of forty to forty-three miles an hour, all with a slow-running engine of his own design and construction, weighing 170 pounds and developing only 25 to 30 horse-power, whereas the engines used in the Voisin Fréres aeroplanes as built for Delagrange and Farman develop 50 horse-power. The cylinders of the Wright engine are cast separately and bolted onto a broad, flat base that forms the crank chamber. They are water cooled and have a bore of 4 inches and stroke of 4½ inches. Turning at its normal speed of 1,100 revolutions a minute, the engine should develop 30 horse-power. The Wrights, as is well known, do not depend upon the motor for starting, but utilize the energy of a weight of 1,700 pounds that is raised to the top of a steel derrick and, in descending, "launches" the aeroplane from a single wooden rail placed on the ground. By the time the machine reaches the end of the rail it has attained a velocity sufficient to enable it to rise, and the propellers take up the work of keeping it in the air.

Two propellers are used, placed one-third the distance from center to the ends of the wings on either side, and with shafts slightly above the horizontal center. Each propeller has two peculiarly-shaped blades made of wood, and is driven by a bicycle chain running over sprocket wheels. To prevent lashing, long chain cases of bicyble tubing are made for the chains to run in. The engine is mounted to the right of the longitudinal center to balance the weight of the operator, who sits on the left; consequently, one of the driving chains is longer than the other. In order that the two propellers may turn in opposite directions and so balance each other when in action, the longer chain is crossed, reversing the direction of rotation of the propeller. A longer set of propellers, providing greater thrust, is fitted when an extra passenger is to be carried than when the aviator flies alone. These have a diameter of 7½ feet and are geared to the crank-shaft in a ratio of 10 to 33, by the use of large sprockets, so that the propellers revolve about four hundred times a minute. No clutch or change speed gearing is interposed between the engine shaft and the propellers, and the engine is started by turning the propellers over by hand.

No carbureter is fitted to the engine, the fuel being forced directly into the intake to each cylinder, by a geared pump, at a predetermined rate that cannot be altered when in the air. Consequently, the engine runs at constant speed and the operator pays no further attention to it after getting started. When it is desired to bring the machine to the ground, the ignition is cut out simply by touching a string that short circuits the current from the high-tension magneto, causing the engine to stop at once.

The Farman and Delagrange machines, Figs. 3, 4 and 6, built by the Voisin Fréres, are constructed after the same model. In actual performances, they are second only to the Wright machines. Up to the end of October, 1908, Henry Farman was the only aeroplanist who had flown straight across country instead of merely circling over open military grounds. On October 30 he flew direct from the grounds in Mourmelon to Rheims, a distance of sixteen miles, rising to

heights varying from 120 to 300 feet, passing over the tops of trees and across fields and streams. A rather strong wind blew from behind, but did not interfere with the steering. The time of the flight was about twenty minutes. Delagrange, on September 17, broke the European record by remaining in the air for a few seconds less than half an hour, though Orville Wright had flown for more than one hour at Fort Myer only the day before, and four days later Wilbur Wright stayed up more than an hour and a half.

The wings of the Farman and Delagrange aeroplanes are rigid along both front and rear edges; and there is no arrangement for restoring lateral equilibrium. The center of gravity is brought very low, however, by the weight of the wheeled attachment which hangs below the lower plane. The "wings" are 40 feet from end to end and 6 feet wide. They are spaced 6½ feet apart and are set at an angle of 15 degrees from the horizontal when the machine is at rest on the ground. A single-plane horizontal front rudder is used, 16½ feet from end to end, and 39 inches wide. Its angle of inclination is in this as in the Wright engines, the gasoline being pumped to a distributor in the head of each cylinder, where it remains until the suction stroke. This engine is mounted on wooden bars almost in the geometrical center of the biplane, directly back of the operator's seat.

Of numerous other aeroplanes of the biplane type that have flown short distances, the one of most interest to Americans should be the "June Bug," built and flown at Hammondsport, N. Y., where it won the international trophy last July. This machine is very light, weighing but 430 pounds, including the tricycle upon which it runs on the ground. The framing is of tough woods and bamboo, and the covering of the wings is silk, varnished. The wings, which are tapered and curved toward each other at the ends, present a supporting surface of 408 square feet, so that with the operator at his post, each square foot has to lift only about 1½ pound, whereas the Wright machines have lifted 2½ to 3 pounds per square foot. A Curtiss air-cooled engine of 30 horse-power is used. It has eight cylinders of 3⅝ by 3¼ inches bore and stroke,

Fig. 6. Delagrange's Aeroplane in Flight at Issy-les-Moulineaux, France.

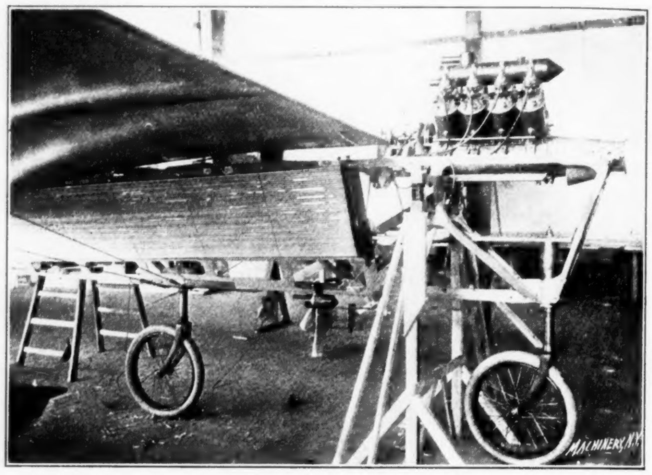

Fig. 7. Antoinette 50-60 H.P. Eight-cylinder Aeronautical Motor.

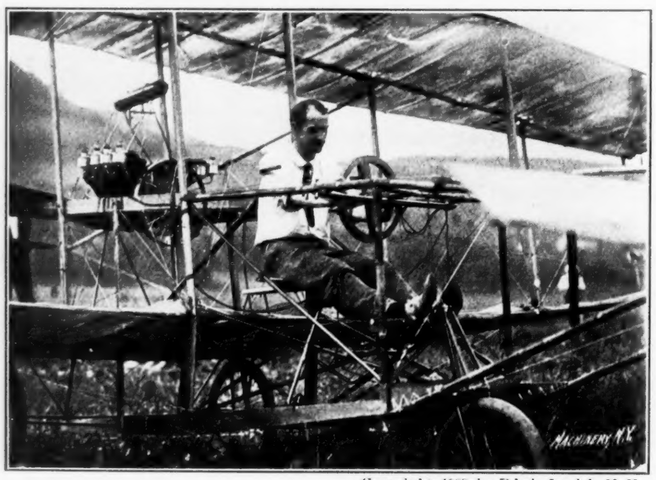

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Fig. 8. Power Plant and Operating Mechanism of Curtiss' "June Bug."

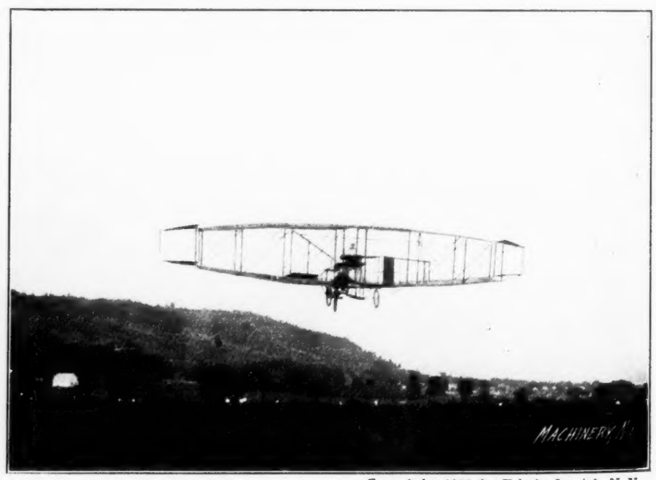

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Fig. 9. The "June Bug" in Flight at Hammondsport, N. Y.

controlled by a rod that extends directly back to a connection by universal joint with the shaft of a steering wheel like that of an automobile.

To give increased longitudinal stability, a large "tail" is attached at the ends of four rearwardly-extending rods. It is cellular, having canvas sides as well as upper and lower planes. The planes have the same form as the main planes and are 6 feet broad by 10½ feet from end to end at the rear edge and 8 feet at the front. A vertical rudder is mounted in the center of this tail and its movements are controlled by wires connected with the steering wheel.

A 50-horse-power Antoinette special aeronautical engine, Fig. 7, weighing with attachments 250 pounds, drives a single two-bladed propeller that is attached directly to the crankshaft. This turns at the same rate as the engine—1,200 revolutions per minute. The eight cylinders of the engine are arranged in two lengthwise rows set at an angle of 90 degrees to each other. They are water cooled and have a bore and stroke of 5⅛ inches. Direct injection of the fuel is employed with normal R.P.M. rate of 1,800, and is, like the Antoinette, of V type. The engine is bolted to a pair of parallel wood bars directly behind the head of the operator and almost in the exact center between the two superposed supporting planes of the machine. The power plant and operating mechanism are supported on a tricycle having bicycle wheels, which has been driven on the road, with the aeroplane wings and tail removed, at a speed of forty-five miles an hour simply by the thrust of the propeller blades in the air. Going to the other extreme from the designers of the engines previously described, Curtiss fitted a carbureter to each of the eight cylinders.

Movements of the "June Bug," Figs. 8 and 9, in the air are controlled by means of a single-plane horizontal rudder in front, a single vertical rudder in the rear, and by a system of movable tips on the ends of the wings. The rudders are manipulated by a wooden steering wheel having an outer peripheral groove in which lie a pair of small cables that extend to little pulleys on the framework at either side and

thence backwardly to the rear rudder. To elevate or depress the front rudder, it is required merely to push or pull on the wheels whose shaft is connected with levers that move the rudder. The wing tips are moved almost involuntarily by the operator in his instinctive leaning of the body away from the side of the machine that begins to restore lateral equilibrium. Wires connected with the tips pass through small pulleys and are attached at their ends to a light cradle made of steel tubing which fits around the shoulders of the aviator when seated. Thus, movement of the trunk of the body to one side elevates one set of tips and decreases the resistance on that side, and depresses the tips on the opposite side to the same degree, increasing the air resistance.

Of the many monoplanes that have been built on the principles evolved by Professor Langley, those of Louis Bleriot, Santos-Dumont and Messrs. Gastambide and Mangin have given the most promising results. As a class, the single plane machines seem to lack the stability and structural strength of the biplane. A number of accidents have occurred through the collapse of the wings, the plunging of the machines to the ground, and their complete capsize. In many respects the monoplane of Santos-Dumont (who has built and tried about a score of flying machines and airships) is most worthy of attention. It is the only one that up to this time of writing has flown more than 100 yards and alighted safely. Bleriot on June 29, 1908, flew 300 feet with his new monoplane driven by a 50-horse-power engine and having a wing spread of 36 feet and a total length fore and aft in excess of this; but on November 18, 1907, Santos-Dumont drove his monoplane, in Paris, 450 feet at a height of about 20 feet from the ground. The machine is very small, having a pair of wings with a spread of only 16¾ feet and a width of 6 feet, giving a supporting area of 107 square feet. The wings are mounted, together with the engine, on a tricycle, the complete apparatus weighing only 123½ pounds. It is driven by a two-cylinder opposed air-cooled engine of 17 to 20 horse-power, weighing 48½ pounds and mounted at the extreme front above the operator's head, where it drives a two-bladed propeller. Movements of the monoplane when in the air are governed by combined horizontal and vertical rudders attached by universal joint at the end of a 20-foot bamboo pole stayed by wires, and also by a horizontal rudder in front and a pair of kite-shaped vertical rudders secured to the sides of the tricycle under the wings. All of these rudders are controlled by a single operating handle.

While it is unsafe to prognosticate with regard to the development of so new a form of invention, one cannot but feel that the practical flight machine of the future will tend toward much smaller horizontal dimensions than those of most present aeroplanes, have a larger factor of safety, and positive means of maintaining lateral and longitudinal equilibrium that will enable any person with due caution to avoid absolutely a sudden dash to earth. At first we may expect that they will be built small and light for individual use, but later increase in capacity to two or four persons as the public grows accustomed to their use. They will be less expensive than automobiles and will be extensively used for private pleasure and for racing, as well as for scouting and other military purposes.

* * *

The Association of Licensed Automobile Manufacturers has tentatively adopted a design of quick detachable rim for automobile pneumatic tires. It is the desire of the mechanical branch of the association to settle on a standard design which will meet general approval, and which will do justice to all concerns that have developed detachable rims. The tentative adoption of one style was for bringing about conformity of action, and is in no sense a final adoption. The final adoption is contingent upon other than mechanical questions. This is the substance of a statement made by Mr. Albert L. Pope, chairman of the tire committee. The importance of a quickly detachable rim in the automobile trade is so great that it seemed necessary to take a decisive step that would lead to uniformity of design. It is probable that the detachable rim will become almost universally used because of the convenience and quickness of repair of punctured tires, made possible by this construction.

THE LAWRENCE INDUSTRIAL SCHOOL.*

The Lawrence Industrial School opened October 19 with a registration of over 900 students, and resumes its classes with the most brilliant prospect of another year of success. This school is the only independent industrial school in Massachusetts, with independent buildings, and with an independent board of five trustees. It was established under the industrial school act, and opened last year with evening and day classes for those already engaged in the trades. This school represents a new phase of education; namely, a practical education by which the industrial worker may meet his daily needs. Industrial superiority depends upon industrial training and education, and this training and education can be accomplished best, not by the necessarily rude methods of the mill and shop, but with those methods supplemented by industrial education. It was such a school that Lawrence lacked until a few years ago. The deficiency has been supplied with a speed and on a scale of which no one dreamed. What has been accomplished reflects great credit on the enthusiastic, far-sighted, and energetic trustees: Dr. M. F. Sullivan, president of the board of trade; James Barnes of the American Woolen Co.; Walter H. Summersby, agent of the Atlantic Cotton Mills; A. X. Dooley, attorney at law; John B. Cameron of the Central Labor Union; and the principal and chief executive officer, William H. Dooley. Principal Dooley has made an extensive study of industrial school methods in nine European countries. The result is that Lawrence and the surrounding cities and towns are now provided with the means of educating in a systematic manner their large number of textile and metal workers. No entrance examinations are held, the only qualification being that the applicant for admission be an operative. The school is free. Text-books are edited by the instructors, and printed by the commission. The problems, drawings, and notes are practical, the drawings and notes coming from the shop, so that the school keeps in touch with the industries. These notes and problems are obtained by means of a question box. The instructors are practical men, working in the industries and conversant with the needs of the operatives.

Practical Instruction in Reading and Making Drawings.

The evening instruction appeals to the student immediately at the beginning of his work. For example, a young machinist had received a reprimand from his foreman because he could not read a working drawing with sufficient skill to do his daily work properly. He enrolled in the mechanical drawing course in the evening drawing school, thinking this course would meet his deficiency. He found that the first two lessons were concerned with lettering plates, the next three with drawing straight and curved lines and the handling of instruments, and that the remainder of the term was spent on the projection of points, lines, surfaces and solids. During all this time he was receiving in his daily work the same reprimands, and was therefore debating in his own mind the value of the drawing course. It is undoubtedly true that the drawing course this teacher had outlined in the drawing school is a proper one for teaching mechanical drawing for those who are to be draftsmen, but the average apprentice machinist, as well as this young man, does not see the direct application of this instruction to his work. He enrolled in the drawing school for a definite purpose. To be sure it was a narrow one, but nevertheless it had economic value to him. As the result of this young machinist's experience, the principal immediately offered a course in blue-print reading and arithmetic for machinists. This is one of the most popular courses in the school.

The first lesson begins with some elementary instruction in the reading of simple drawings; to teach him in five lessons where to look for the dimensions denoting length, breadth, and thickness; to show him the principles of simple sectional drawings and have him comprehend the laying out

* For additional information on this subject see the following articles previously published in MACHINERY: Evening School of Trades—Rindge Manual Training School, Cambridge, Mass., July, 1908; Can a Boy Learn a Trade in a School? April, 1908; Promoting Industrial Education, May, 1907; A Step Toward Increased Facilities for Industrial Education, December, 1906; An Experiment in Industrial Training, September, 1906.

of holes for drilling. Instead of leaving school at the fifth lesson with no instruction which appealed to him, the students have received enough in those five lessons to fit them to meet the needs of their foreman, and are anxious to continue and receive the more definite and thorough instruction in the theory of mechanical drawing so as to be able to make sketches of machines and parts by means of a ruler and compass. It is not the aim of this course to teach the students to make pretty picture drawings.

Practical Mathematics.

The instruction in the various branches of mathematics is adapted to meet the needs of the mill operative, the machinist and the steam engineer. The terms used in the class room savor of the shop and mill. For example, the method of finding the heating capacity of a boiler does not appeal to the weaver in the mill, and, on the other hand, finding the size pulley for a certain loom does not awaken the interest in the steam engineer as much as the problem involving the same operations dealing with work in the boiler room.

Students Classed by Vocations.

All our students are classified into vocational classes according to their trade. For example, there is a class in arithmetic for engineers and a separate class in the same class for boiler firemen. Again the textile designers have a class in arithmetic called cloth calculations and the loom-fixers a class called loom calculations. This idea carries out the plan of the old workingman's guilds. Each guild was formed for the purpose of social intercourse and mental stimulus. Each trade had its own guild. The daily trade experiences of each member became the property of all members. Discussion relating to the practices of their chosen trade occupied their attention. So, to-day, workingmen have common trade interests. Our evening students are grouped according to their occupations and in this way have an opportunity to talk over these interests. The teacher acts as a leader and draws out the students in telling their trade experiences and, through the expression of these various opinions of the work, practical solution of the particular problem at hand is obtained. It is difficult to get students to recite and express themselves at the blackboard. A free discussion of the point at issue makes the student lose his self-consciousness and before he is aware of it he is at the board illustrating his particular method of solution. Of course such discussions are under the wise guidance of the teacher.

Provision for Irregular Attendance.

Provision is made for students who cannot attend but once or twice a week. It is quite common for students to stay away because they cannot attend "regularly." This applies to a great many textile workers. In prosperous times the mills are run evenings and the employes are expected to work overtime. But they can usually get away for one night in the week during such times. They cannot always tell definitely what nights they will be called upon to work. Students who are working overtime are allowed to attend any night during the week after the work is fairly started. Such a plan is feasible. Boiler firemen alternate in working day and night. A fireman who works days this week will work nights next week, and so on. The week he works nights he attends the day classes, and the next week he attends the evening classes.

Scope of Instruction.

A certificate is awarded each person completing a course. Day classes are formed for the convenience of those who are unable to attend the evening sessions. The school is in a position to compete with any of its kind, over $32,000 being represented in its up-to-date woolen, worsted, cotton and steam machinery. Classes in the following subjects will be formed for both day and evening pupils: Woolen and worsted spinning, woolen and worsted weaving, woolen and worsted finishing, dobby and jacquard weaving, cotton spinning, cotton weaving, loom fixing and loom calculations, mill arithmetic and mill bookkeeping, elementary and advanced textile designs, elementary and advanced cloth calculations, industrial and commercial electricity, steam engineering for firemen, steam engineering for engineers, arithmetic for firemen and engineers, blue-print reading, machine drawing and arithmetic for machinists, shop arithmetic, industrial and commercial chemistry, experimental and practical dyeing and dressmaking for working girls.

The courses of woolen and worsted manufacturing are arranged to meet the daily needs of those working in these industries. Instruction is given in all the various processes employed in adapting the wool fiber to cloth, namely: Sorting, scouring, carding, combing, spinning, designing, weaving, dyeing and finishing.

Cotton Course, Dyeing and Chemistry.

The cotton courses are designed to meet the needs of the men working in these industries—to make better workers of them and to train them to think and take an interest in their work. If a sufficient number registers, classes will be formed in picking, carding, drawing, roving, spinning, combing, designing and weaving. In connection with this work a course in knitting is offered. The equipment of the department is of the best up-to-date cotton machinery.

Experimental laboratory, dye house and industrial chemical laboratory work is carried on in a building located in an ideal spot for a dye house. It is situated on the banks of the Merrimac just above the falls, away from the class rooms and dwellings. It is modeled after one of the most practical experimental laboratories in the country.

Steam Engineering and Electricity.

One of the strongest departments of the school is the course in steam engineering and electricity. The course consists of lectures by practical men who are specialists in their respective branches; arithmetic and practical mathematics for engineers, firemen, etc., and laboratory practice in steam engineering. The steam engineering laboratory is one of the best equipped laboratories in the country, consisting of different types of boilers, steam heating apparatus with appurtenances, different pumps in sections, sectional valves and gages, all the boiler accessories, steam engines, generator and many other machines. In addition to all these, pictures, blue-prints and sketches of the above apparatus and other machines are on the wall for study. All the lectures, classes and demonstrations are carefully planned to meet the needs of those working in the trades. Classes are formed afternoons for those working nights, and evening sessions are conducted for those laboring days. This is the first free engineering laboratory in this country.

Limitations of Present Schools.

The purpose of most of our present technical and textile schools is to give the highest possible instruction in science, and to give this knowledge to the operatives of the industry. In order to enter these schools, the student must be a graduate of a high school and have received a thorough preparatory training. Most of the present textile and metal workers have never received over four years schooling and this was before twelve years of age, and the average boy cannot afford to remain unproductive beyond the age of seventeen. Hence the schools fail to provide an education for the great mass of our future industrial workers. The education received in these schools often exceeds the real needs of the metal and textile industries. Hence there is a loss of time which could be better devoted to obtaining practical skill. Then again most of our boys cannot afford to pay $150, the tuition necessary to enter our present textile and technical schools. Neither are there free scholarships provided. In consequence of these considerations, there is found to be need of an industrial or technical school somewhat less pretentious in its course of study, somewhat lower in its requirements, and giving instruction of a character more directly vocational or more directly industrial. This is the aim of the proposed secondary industrial school in Lawrence—a school much needed in every industrial community. A canvass has been made in the city of Lawrence and over five hundred boys have signified their intention of attending such a school, a school to provide a three years' learning for a boy in either the metal or textile industries.

* * *

More people fail from lack of confidence in themselves than from lack of ability.—*The Silent Partner.*

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—4.

WILLIAM P. SARGENT.*

DEFINITE PLANNING.

The general plan for a works designed to employ 1,500 men has already been presented, and we are now ready to take up the definite planning. The more designing, subject to approval, that the construction engineer can have done by outside parties, the quicker and better the plant can be built. This policy is recommended for the reason that no one person can have that definite knowledge of all subjects possessed by those who specialize in a certain line. The designers belonging to the plant can be more profitably employed on work which cannot be carried out except under the engineer's constant supervision.

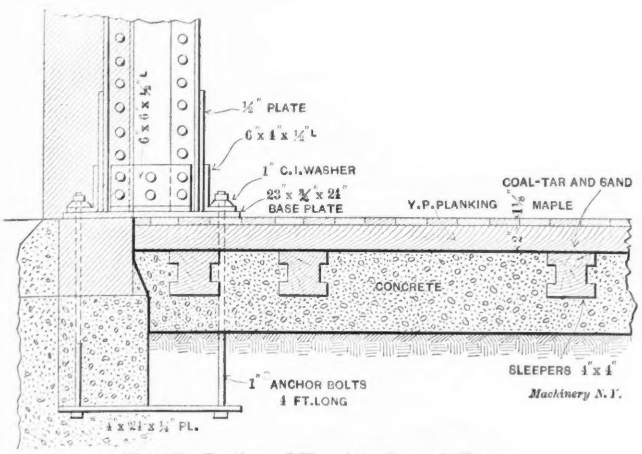

Fig. 28. Section of Flooring, Ground Floor.

An architect should be employed for the buildings, and the engineer should give general instructions and follow up the designs of the buildings; by acting in an advisory capacity the general ideas of the engineer can be closely incorporated. The architect should be made to understand that shop buildings are for use and not for ornament, and should be required to take the responsibility of the accuracy of the figures embodied in his plans. The engineer and the architect should work up the steel design sufficiently to arrive at the tonnage in order to give the steel companies the information required for making bids; it is good policy to permit the steel companies to make the detail design of the structural work, and to enter bids at a tonnage price, the prices being based on an approximate tonnage erected within a given time. The engineer has control of the tonnage on account of the detail construction being subject to his approval.

Data for the Architect.

The following data should be furnished the architect:

1. The block plan and cross sections, already made up.

2. The cost range, within which the buildings are to be designed. For present prices, this should be from $1.50 to $1.65 per square foot for the main buildings.

3. The column spacing determined by considerations of actual necessity and of economy in the cost of steel work: for the erecting shop No. 6, 25 feet, to tie with the span of the wing shops; for the machine shops Nos. 1, 2, 3, and 4, and forge shop No. 5, 16 feet, because of economy and the fact that the bents in the old shops are 12 feet and are almost wide enough; for the foundry No. 8, 20 feet. For the pattern storage building No. 9, 16 feet is suggested, but the previous caution, respecting the laying out of the pattern rack system and the window spacing, should be considered.

4. The bearing power of the soil (obtained from actual tests) and the nature of the foundations proper. Concrete is almost universally used. The cheapest type of foundation consists of a footing 12 to 18 inches thick, for the column piers, and a plain foundation wall uniform in thickness, about two feet deep, between the piers. Reinforcement is used in the footings to prevent breaking in the corner where the pier starts, and in the bottom of the wall to prevent cracking. This type of foundation requires no forms for the footings, and but a plain form for the wall and piers.

5. The loads for which the steel work should be designed. The snow load varies with the latitude, and there is plenty of data to govern. With a gravel roof laid on plank sheathing, 40 pounds per square foot of projected area is often assumed for the total load on the trusses, in the Central States. For the floor loads for the machine shop galleries, 250 pounds live load is sufficient for the class of work to be done. Anyone who has not studied the weight on loaded floors will be surprised at the amount of material and machines required to load a floor to even 150 pounds; in this case we need extra rigidity to reduce the vibrations caused by rapidly moving cranes. For the sand floor, the steel work should be designed for a safe load of 400 pounds and the concrete floor should be designed for a safe load of 600 pounds. The sand will often come in wet and may be 8 to 10 feet high at times, equivalent to a load of 1,000 to 1,500 pounds. For the pattern storage assume a load of 120 pounds, based on an equivalent of 4 feet of patterns solid on the floor. It is well to design this building for the addition of another floor in the future, as this added space can thus be obtained at less price than by building on the ground.

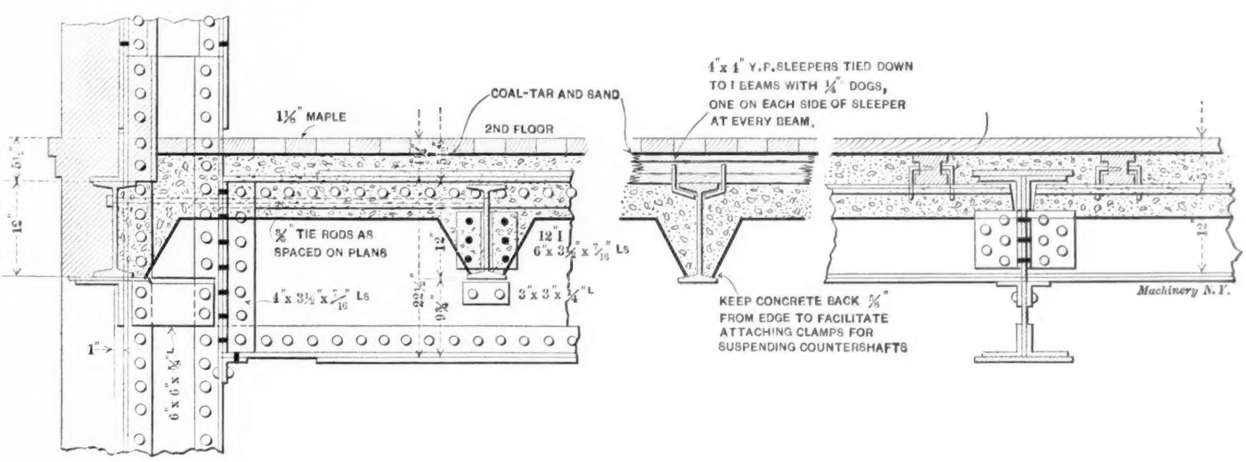

Fig. 29. Section of Flooring in Galleries.

6. The maximum wheel loads of the cranes and the distribution of the wheel loads on the crane girders. The table given on page 19 of Ketchum's "Mill Buildings" is representative for the loads of most cranes. Often the wheel load is taken as equal to the rated capacity of the crane. This is very safe.

7. Brick curtain walls 8 inches thick are sufficient, if built between the columns and well supported by the horizontal members of the steel work. An 8-inch brick wall will conduct nearly 45 per cent more heat than a 12-inch wall, but there is such a small percentage of brick surface that this factor of heat loss will not justify the expense of a wall thicker than 8 inches.

8. Window data. There should be swinging windows as close to the ceiling as possible, and part fixed sash, and part sliding sash, below these to within 4 feet 6 inches of the floor.

* Address: 315 South First St., Rockford, Ill.

except where crane girders and intervening brickwork interrupt. The frames, sash, and glass should be standardized to a few types and sizes.

9. Steel rolling doors for the larger openings, and sliding doors for the openings through which freight cars do not pass, should be provided. There should be a wicket door in each sliding door, and enough other small doors to permit of going from one shop to another, in winter, without opening up the large doors.

10. Floors should be made as follows: 6 to 12 inches of gravel concrete with 4 x 4-inch sleepers embedded; then a

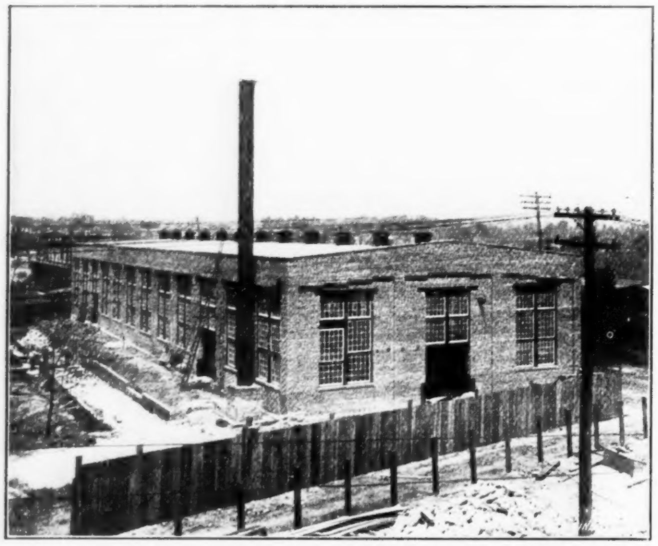

Fig. 30. General Appearance of Shop Building such as Specified.

layer of fine sand and coal-tar; then 2-inch tongued and grooved yellow-pine planking which is spiked to the sleepers. The sleepers should be on 24-inch centers. On the planking is laid a 1⅛ x 4-inch square edge maple top floor. This floor will cost from 22 to 30 cents a square foot, according to the thickness of the concrete. The contract for the floors in buildings where machine foundations are to go in, should be let separately on a square foot basis. This avoids laying out the tools at an early time, and gives the shop officials time to decide on a satisfactory layout. Fig. 28 shows section of ground floor, and Fig. 29 gallery floor.

11. Fire-proof vaults should be provided in No. 8 building, foundry office, and on all floors of the No. 9 building.

12. Locating wash rooms and closets in large works is always a problem; placing them on the mezzanine floors, wherever possible, is about the best solution; and this is possible with the headroom that we have provided.

Fig. 30 shows the general appearance of the type of design outlined above.

General Work for the Engineering Force.

While the architect is working up the shop building plans, the power plant should be designed complete, under the engineer's supervision. The drawings should be prepared early, as deliveries on power apparatus are long, even in dull times. Standard apparatus should be used if the conditions permit.

At about this point in planning shop improvements, the need of a detailed list of the matters requiring consideration, becomes apparent. A good way to get up a reasonably correct list at the start is for the engineer to sit down with some one of his men, conversant with the general plan and experienced on construction work; then with the survey plat, block plan and photographs of the site before them, they list, independently, every item that comes to each man's mind. The two lists when combined should agree fairly well.

The following list gives the main headings that, in general, would enter into such a list. Besides the building numbers of the block plan, the yard space North is designated by the letter A; the space East by B; the space South, inside the fence, by C; the space South, outside of the fence, by D; the yard spaces between the wing shops by E_1, E_2, E_3; between the machine shops and foundry by F; and between the foundry and pattern storage building by G.

Suggested Itemized List of Details Necessary to Complete the Plant.

Required definite planning, securing bids and prices, contracting and purchasing, constructing or executing of the following: Clearing the site, selection of grades for floors, tracks, etc., staking out buildings, tracks and fences.

Underground Work.

Sewers.—Storm sewers, to take care of roof drains and surface water in yards.—Sanitary sewers, to reach all buildings, excepting Nos. 10 and 11.

Water Service.—Fire and sprinkler mains, to reach all buildings and hydrants in yards.—Shop service, to provide drinking water, for flushing, and for wash rooms.—Condenser main from steam and discharge pipe.

Power Mains.—Heat to all buildings excepting Nos. 10 and 11.—Steam to forge shop No. 5 and dry-kiln No. 10.—Air to all main buildings.—Oil to No. 5 and No. 8.

Foundations.—Building foundations.—Holes in building foundations for service mains and for power tunnel.—Machine foundations in shops and in power plant.—Crane runway foundations in yards.—Pits in erecting shop and foundry.—Power tunnel between buildings.

Work Above Ground.

Lighting.—All shop interiors, the yards between the shops, all gateways and main avenues within the works.

Power.—To all shops and yard cranes.

Plumbing.—Air piping.—Water piping.—Sprinkler system.—Gravity tank.

Tracks and Equipment.—Tracks, switches.—Track scale.—Scale house.—Locomotive shed.—Watchmen's sheds.—Switch engine.—Locomotive crane.

Telephone system.

Structural Steel.—Roof loads, floor loads, crane loads, column loads.—Provision for extensions, for attachment of jib cranes, for support of counter-shafts and line-shafts, for fire-proofing, for attachment of trolley hoist runways, for support of top end of window-frame, for support of pipe coils.—Elevator guides and framing, railings, anchor bolt diagram, anchor bolts, plates and column foot-plates.

Concrete Floors.—In all buildings excepting No. 5, No. 8 and No. 11.

Cement Floors.—For all wash rooms, boiler room, pattern storage rooms.—Treads for stairs, stair landings.

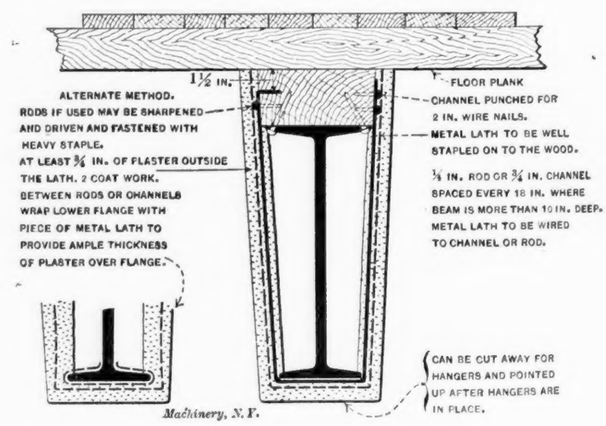

Fig. 31. Fire-proofing of Steel Beams.

Fire-proofing.—Fire doors in all fire walls.—Metal frames and wire-glass windows at junction of wing shops and No. 6 building, on foundry side of boiler house, on either side of fire walls.—Concrete or mortar protection of exposed steel work in No. 9 building. (Fig. 31 shows an economical method of protecting beams and columns, suggested by the Associated Factory Mutual Insurance Company.)

Concrete Roofs.—Over charging floors, over dry kiln.

Walls.—Brickwork, anchors, pilasters, parapets, coping, wood for lumber shed.

Windows.—Widths, heights of frames, size of sash, size of glass, pivot windows, balanced sash, weighted sash.

Doors.—Rolling, sliding, wicket, and small doors.

Roof.—Gravel, sheathing, wood purlins, saddles, strainers, downspouts flashing and counterflashing, ladders.

Floors.—Under planking, top floor, troughs for piping, industrial tracks.

Miscellaneous.—Stairways, vaults, core-ovens, offices, elevators, cranes, trolley hoists, traveling jib cranes.

Power Plant Equipment.—Engines, generators, switchboard, boilers, stokers, ash and coal handling apparatus, feed-water heaters, water softeners, condensers, feed-pumps, fire-pump, compressors, receiver, engine room crane.

The preceding list does not enumerate the details, as each building has its own characteristics. Each building should be taken separately and the general heads enlarged upon according to the conditions. The listed items should be checked off, as soon as the drawings required are under way. Consulting with the various foremen of departments will constantly add to the list, as various improvements are suggested. These little things bring the cost up amazingly, and that is the reason why the engineer should hold to a broad range in his original estimate.

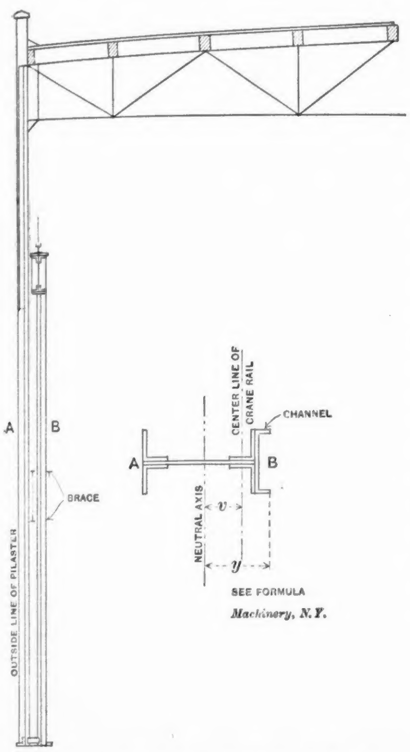

Fig. 32. Economical Form of Truss and Column.

Time Chart to Govern Work.

After listing the details of the work, a time chart can be made out, to be used in controlling the commencement and completion of the various details. This time chart or schedule is the most important record used in completing a series of improvements within a definite time. It is as important, as a train schedule is to a railroad.

The construction of a large plant, naturally, is separated into divisions, each complete in itself. The time chart should be divided accordingly, for instance, machine shop No. 1, machine shop No. 2, etc., and into general divisions which cover the work that cannot be charged to the separate buildings.

We should have a chart for each division, and each class of work for each division should have columns as follows: Drawings, dates of commencement and completion; account number, against which to charge cost; name of contractor; date of order or contract; date when work should be commenced; date when commencement is promised; date of promised delivery; date of delivery; date when work should be completed; date of promised completion; date of actual completion; estimated cost; actual cost; notes. Each item of work should have three lines, so that revisions can be made without erasing the original dates. Revisions generally are necessary, as a spell of bad weather, or a strike, can throw out of gear the best laid plans. The dates should be adhered to, and the contractors should be held to their promises irrespective of the state of subsequent work. The following instance shows the importance of this latter statement. The general contractor on a certain building, was delaying the completion of the foundations, giving as a reason *that the steel work was not in sight.* At the same time, investigation developed that the steel company was delaying *because the foundations were not completed.*

Foundations.

The depth of the foundations will depend upon the depth of excavation required to reach a soil with a minimum bearing power of two tons per square foot. The figures given in "Trautwine" are safe for estimating, but actual tests should give the data for specific cases. The footings should be proportioned to sustain the actual dead load of buildings and an average of the added loads on the building superstructure, omitting the snow load. For the crushing strength of the concrete piers, 250 pounds per square inch should not be exceeded for plain concrete, and 700 pounds per square inch for reinforced piers. The area of the footings will be about 7.5 times as great for a gravel subsoil as the area of steel column foot plates. The total weight bearing on the foundations will approximate 300 pounds per square foot of ground floor space for gallery shops, such as Nos. 1, 2, 3, 4, and 8; 250 pounds for high shops without galleries, such as No. 6; and 200 pounds for low shops without galleries. These loads will require, respectively, 1/50, 1/60, and 1/90 cubic yard of excavation, and 1/75, 1/90, and 1/135 cubic yard of concrete per square foot of ground floor space. The foundation wall for carrying the weight of brick work between the columns, if made about 2 feet deep and reinforced, will cost only half as much as foundations that are carried down to the level of the column footings.

Structural Steel Details.

In order to secure sufficient strength of steel work at a low cost, the following points should be watched, either in the design or in the checking. Crane loads and concentrated loads on the trusses add complexity to an otherwise simple proposition.

Trusses.—The stress diagrams should first be checked. The stresses in the upper and lower chords can be found approximately by the formula:

$$\text{Maximum stress per square inch} = \frac{W \times L}{8 \times D},$$

in which W = the total weight on both columns (including the weight of the truss); L = the length of the span between columns; D = the average depth of the truss in feet. The writer has compared the weight of a number of trusses for flat pitch roofs, for column spacings of 16 and 20 feet, with plank roofs and wood purlins, and none exceeds 5 pounds per square foot of projected area of roof. Calculations based on a total load of 40 pounds per square foot of projected area should be safe for the latitude of Chicago and the South, and 50 pounds for New England. One of the leading structural firms in the Central West recommends for flat roofs the form of truss shown in Fig. 32, the height in the center being about one-tenth of the span. Angle sections are used and the price, erected, in the vicinity of Cincinnati is about $60 per ton (October, 1908). The height specified requires about 25 per

Fig. 33. Laying Split Tile Pipe for Running Pipes Underground.

cent more metal than if made one-eighth of the span, but the added cost, at $60 per ton, for the shallower truss is less than the added cost of the brickwork in the walls for the higher truss; and it will not take any more time to erect the heavier truss, but will require more time to build the higher wall. The allowable stress per square inch of the various truss members can be found in Kidder's "Architects and Builders' Pocketbook," pages 463 to 470, or on pages 143 and 144 of the Cambria, or on page 209 of the Jones & Laughlin handbook.

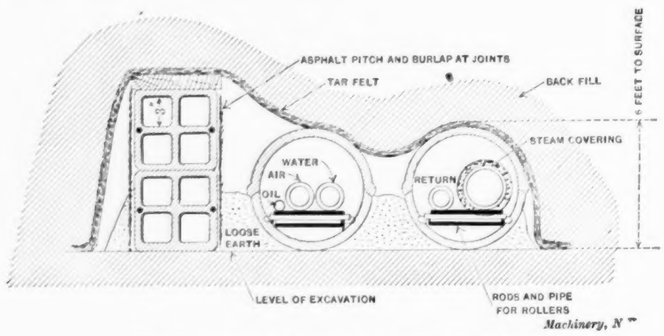

Fig. 34. Section of Conduits shown in Fig. 33.

Columns.—Many different forms of columns are used to support roof and crane girders. The column, shown in Fig. 32, is probably as economical as any. In a general way, the angles on the girder side (sometimes reinforced with a channel) are designed to support the crane loads, and the angles on the other side are designed to carry the roof. This form of column will cost from $65 to $70 per ton erected, at the present time. The area of section required for this form of column is found by the formula

$$A = \frac{I}{p}\left(P + \frac{3\,V P_e}{y}\right)$$

in which $A =$ area of column section,
$p =$ maximum allowable stress per square inch,
$P =$ total load, both eccentric and concentric,
$P_e =$ eccentric load,
$V =$ distance of eccentric load from neutral axis of the column,
$y =$ distance of extreme fiber from the neutral axis on the loaded side.

The number of formulas giving values of p are many, but the values given in the steel companies' handbooks are a good basis, as they are tabulated. Increasing these values about 7 per cent will give the allowable stresses according to the Chicago building code. Increasing them 11 per cent will give approximately the stresses used by the steel companies in calculating the safe loads for their special forms of columns.

For columns for very light loads, built into walls, single I-beams can be used, costing about $56 per ton, erected. Short columns, made up of four angles, laced, require the least area of section for light loads, and will cost about $75 per ton, erected.

Crane Girders.—These should preferably be made of angles and plates with a generous depth, as deep girders help to stiffen the columns, and minimize the effects of the longitudinal thrust of the cranes, which is a great deal more than generally assumed. From records of current consumption of 30 ton cranes, starting with load, the thrust on each girder is equal to 40 pounds multiplied by the number of tons load and the total weight of the crane.

Lintels—Channel girders with cast iron separators are the cheapest for a given load, but lintels made up of an I-beam, with a plate riveted to the bottom flange, are neater, as the steel is not exposed to view. In general, sections less than ¼ inch should not be used, and in forge shops a sixteenth of an inch should be added, as the extra thirty-second on a side is better protection against the destructive action of the gases than any paint, although the paint should be there too.

Stairs.—These should be formed of channels for horses, and the treads of channels with flanges turned up, and filled in with cement and cast-iron chips mixed. Pipe railings should be better secured to the channel horses than by the usual means of malleable fittings, as these are rather too weak.

Elevator Towers.—Where hydraulic plunger elevators are not used, towers made up of angles diagonally braced should be built from the ground up, thus relieving the floors of this load. The hatchway should be 2 inches longer than the desired length of platform and about 2 feet wider, to provide for guides, counterweights and cables. The tower should have a platform at least 15 feet above the upper floor for the winding engine. It is a mistake to merely provide openings for an elevator and to leave the means of support as an after consideration.

Anchors, etc.—Holes should be provided in columns and girts for anchors for the brickwork, and in lintels for attaching the window frames. A light angle on either side of the frame and extending down to the next lintel or girt, with holes punched at intervals of 4 feet, will permit of erecting the frames in advance of the brickwork and will obviate the use of jamb-blocks (wooden blocks built into brickwork and nailed to the frames).

Relation of Types of Construction to Insurance Rates.

The following table shows the basing rates of one of the Inspection Bureaus of the Central States, and the modifying factors, as applying to industrial plants.

RATE IN CENTS PER $100 PER YEAR, ON BUILDINGS AND CONTENTS.

	Machine Shops.	Foundries, Non-combustible Cupola Platforms.	Pattern Storage.
Two-story mill construction, 10,000 square feet area on each floor	100	135	85
Steel or brick construction	85	115	70
Reinforced concrete or fire-proofed steel construction, buildings	25-50	30-65	20-45
Reinforced concrete or fire-proofed steel construction, contents	50-75	65-100	45-65

When sprinklers are installed in any of the above classes, the rate on buildings is within a range of 20 to 35 cents, where there is from 50,000 to 75,000 square feet of sprinkled area. Additions to basing rates are made for more than 20,000 square feet in one area ground floor, and more than 10,000 square feet on second floor, and when cupola is less than 10 feet above roof. Defective wiring carries a charge of 10 cents, and when there is no city fire protection 25 cents is

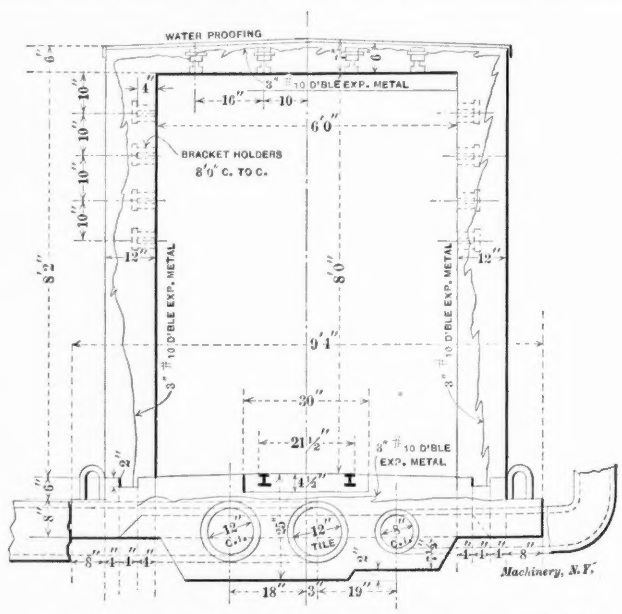

Fig. 35. Section of Tunnel for Pipes and Electric Conductors and Transportation of Castings.

added to all rates. Rates are modified for A. D. T. watchman service, stand pipe and hose, chemical extinguishers, etc. In large plants, where a blanket policy covers, the insurance companies are not always strict about enforcing underwriters' rules, but it is to the owner's interest to make the plant safe and avoid as far as possible the loss due to interrupted business caused by a serious fire. Therefore, preventative means, such as enclosed elevator hatchways, stairways with metal lath and plaster, wire glass windows, fire doors, etc., are well justified.

Power, Steam and Water Distribution.

Electric Mains.—The private plant has a choice between overhead work and underground conduits or tunnels. The advantages of overhead distribution are first cost and efficiency. For underground distribution there is a choice between multiple tile ducts having spaces for four or six conductors, and tunnels used also for steam and water and air pipes. This is objectionable as it is difficult to keep the wires away from the hot or warm pipes at all points.

Pipe Mains.—Underground work is the most natural means of distribution. The general method is to group all piping and wiring into a tunnel. This gives perfect accessibility, but the expense is hardly justified unless the tunnel is necessary as a means of communication between various parts of the plant. A compromise method of distribution is by means of split, or lidded tile pipe. There is not the accessibility, as in a tunnel, but the difference in first cost is so greatly in favor of the split tile, that the expense for occasional excavating and repair of a leak is well justified. The pipe mains, laid in split tile, can be tested as severely as desired before putting on the lid and back-filling. A leak in a steam pipe is easily found on account of the heating of the ground in the vicinity of the leak. Fig. 33 shows two runs of this pipe, ready for the pipes. Fig. 34 is the cross-section of this line and shows the simplicity of this means of underground distribution. A tunnel must be necessarily large enough for added pipes and for men to work. Fig. 35 shows a cross-section of a tunnel for both power and transferring castings, and Fig. 36, a tunnel for power distribution alone.

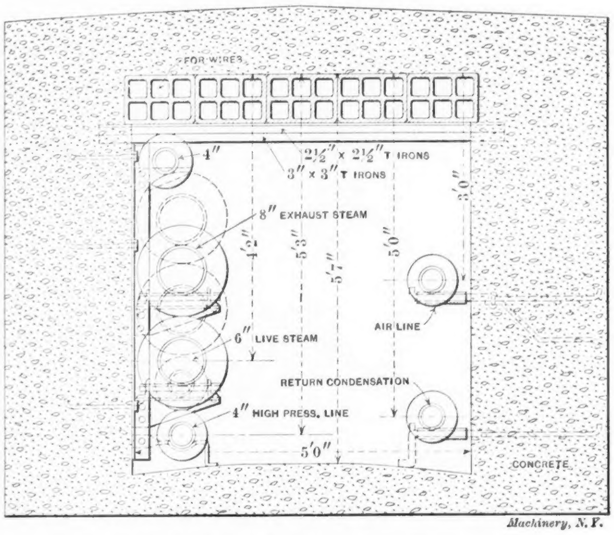

Fig. 36. Cross-section of Tunnel used for Pipes and Electric Conductors only.

The work shown in Figs. 33 and 34, for a distance of 260 feet, actually cost, in 1907, per lineal foot, complete, ready for use, with steam, water and current, $3.30, excluding the cost of the copper cables; all labor and material, excepting cables and wrought iron, $2.00. These costs were within 5 per cent of the estimate. In comparison, the estimated cost of a tunnel 4 feet by 6 feet inside was about $7.00 per foot, ready for piping and wiring. Adding to this figure the actual cost of piping, and labor of installing, $1.30, and the cost is $8.30 as compared with $3.30.

* * *

The Schlick gyroscopic apparatus for preventing the rolling of ships at sea has lately been installed on the British passenger steamer *Lochiel*. According to *Engineering*, the apparatus has proved a success in actual use, and decreased rolling of a total angle of 32 degrees to a roll from 2 to 4 degrees, an amount which is barely perceptible to the passenger. The apparatus has previously been tried in England on an experimental basis, but this is the first time that it has been installed in a British passenger steamship. The gyroscope is driven electrically, and requires very little attention. The design has been simplified, is more compact than the previous one, and takes up a comparatively small space in the steamer. It can be easily thrown in or out of action according to the requirements.

INVENTORS VS. EMPLOYERS AND ASSOCIATES.*

E. C. SMITH.†‡

"What did *you* invent?" This question was propounded to one of two alleged joint inventors by an astute attorney. It developed, as the attorney expected, that the interrogated party had no part in the conception and development of the device invented, but merely a pecuniary interest therein. Therefore the patent at issue was void, because it had been falsely sworn to, one of the parties to the patent application having taken oath that he was a co-inventor when he was not.

A misconception, considerably widespread, exists concerning "invention"—the mental conception, and the embodiment of the mental conception—and the title "inventor." The embodied invention possesses property value which can be secured for a term of years by "letters patent." This property value, or right and title in and to a patented invention, is transferable. It can be shared with others or disposed of in toto, but only by assignment.

The title to inventorship is not transferable, for the simple reason that the mental process or act of inventing is not transferable.[1] The astronomer who discovers a new star is *the* discoverer. The discovery is his act and though he may see fit to attribute a share in the discovery to another, the statement is false unless that other was directly instrumental in the discovery. It is not sufficient that he was with the discoverer at the time. Even though he provided the instruments with which the discovery was made, he is not the discoverer or a co-discoverer. In the same way, the inventor may not share his title to inventorship with his friend as a courtesy, or with him who finances his efforts as a measure of security to the latter's property rights in the invention. Notwithstanding the simplicity of the foregoing proposition, its dictates are frequently transgressed, and the following actual examples indicate various forms in which the transgression takes effect.

"I want *B* to go in with me on this patent. He has helped me out a lot of times, and I want him to share the credit and profit of this thing with me."

Again: "*C* has worked on this thing with me and I am going to let him in on the patent as one of the inventors, to encourage him. He hasn't really invented anything, but has made some good constructions. It's good policy to call him one of the inventors."

The third case is piratically startling. A skilled mechanic was employed and paid to develop a certain machine. He, in turn, delegated a skilled designer to the work, leaving it in the designer's hand and devoting no attention to it personally, whatever. The designer made some patentable improvements and his employer blandly told him to prepare the requisite patent application drawings, and he himself would apply for the patents. The designer, however, knew his own status in the matter and insisted that the application should be filed in his own name, which was proper under the circumstances.

The first two cases are by no means uncommon, and well illustrate how a desired end may be defeated by improper procedure. The third example is also of a not uncommon practice, and it illustrates a peculiar condition, *viz.:* the attitude of certain employers who seem to think modern employment is akin to feudal servitude or vassalage, and that the wages and salaries they pay accord a lien on the

* For previous articles on patents, inventions, etc., see MACHINERY, June, 1908, Patents and Inventors, and previous matter there referred to.

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‡ Edwin C. Smith was born in Elizabeth, N. J., 1869, and received a technical education in the Massachusetts Institute of Technology. He has been employed by the Union Hill Trimmer Co., Boston, Mass., Lockwood, Greene & Co., Boston, Mass.; Universal Winding Co., Providence, R. I., and the Mossberg Wrench Co., Attleboro, Mass., with which concerns he has been draftsman, assistant superintendent, and manager. He had charge of the obtaining of patents, both domestic and foreign, for the Universal Winding Co., and has made patents and patent law a special study. Mr. Smith has had extended experience with economical interchangeable manufacture and special tools required therein.

[1] Robinson on Patents, § 363[1]: "No concession, on the part of the real inventor, that someone else is the inventor or the first inventor, can either change the fact, or confer upon the latter the right to patent the invention as his own."—Hammond vs. Pratt (1879), Vol. 16, Official Gazette, p. 1235. "Parties have no right, by contract, falsely to concede priority of invention."

body, mind, and spirit of each of their employes. Referring to the first two examples, they are subject to the same conditions as are cited in the opening paragraph. Whether one attempts to share inventorship in acceptance of a proffered courtesy, or as a means to protect his financial interest, by subscribing to a patent as inventor, he not only fails of his purpose, but wrecks the whole patent value as well, annulling the rights of the real inventor as well as his own.

The third example is of two types, one of the employer who does not know his own status with reference to inventions made by his employes; the other, of the employer who does know, but takes long chances through lack of knowledge on the part of his employes. In either case, the employers should realize that their interests can be best protected by specific contracts or agreements whereby the employe binds himself to turn over to his employer whatever invention he may make during his employment, which pertains to the business. This is fair, because the stimulus to improve and invent is frequently derived from the atmosphere of invention existing in the particular shop where the employe works; but the fact that one is an employe does not bind him to turn his inventions over to his employer, unless some contract or agreement exists whereby he is compelled to do so.

Employment to make a specific invention or improvement constitutes such an agreement.[2] If one is especially employed to invent, develop, or perfect a device for a given business, obviously, whatever is derived from this work belongs to the proprietor of the business, so far as it pertains to that business. But the proprietor cannot subscribe to a patent application as inventor, unless he himself actually created the patentable improvement. If initiated by the designer, then he alone is the inventor.

On the other hand, mere constructive work is not invention. An invention may be made by one having no experience in construction or in the operation of machines or manipulation of implements. He may be unable to make a correct working drawing. He must, however, have in mind a definite construction which he can so impart to a skilled mechanic, that the latter can produce a working construction. It may be necessary to impart his idea orally, dictating the forms and arrangement of parts, or by sketch or some model, however crude and lacking in the attributes of workmanship or sound constructional embodiment. The information or instruction so imparted must, however, comprise and convey *means* for attaining the end desired. An employer recently claimed to be inventor of a device produced by one of his employes because, he contended, the invention had been made at his own instance. It developed that "his own instance" consisted only in seeing a certain insufficiency in some apparatus of which he was proprietor. He had tried to overcome the deficiency, and had ceased from trying. Months after, an employe who was not a constructive mechanic had, without hint or help, solved the problem simply and satisfactorily. In this case, the employe was the inventor and subscribed as such to the patent application.[3] It is well established that recognition of a need of improvement or advantage of a change is not invention.[4] To constitute invention, the mental process which recognizes the deficiency must develop into a mental act of discovery or determination of specific means to supply the remedy for the deficiency.

The relation of an inventor to his associates requires consideration. The development of any substantial invention and many smaller ones usually requires the concurrent application of many minds. The inventor's work is frequently that of a pioneer. His roads into new fields of endeavor are frequently only blazed trails. Draftsmen, pattern-makers and skilled constructors follow the paths he makes, developing his crude embodiments of accomplishment into permanent structure or fabric. An experienced inventor has remarked, "An inventor is rarely a skillful mechanic. Nervous anxiety to 'see the wheels go round,' precludes that patience and concentration demanded in fine work."

Because of this fact, there are frequently heard on the part of an inventor's associates, such invidious remarks as: "That was really my idea"; or even: "It's really my invention. He had only a crude idea. I constructed it so it was practical." Such individuals lose sight of the consideration of their employment; *i. e.*, knowledge and skill given in the highest degree in their power.

Those who have associated with others in the work of inventive development can readily recall instances where two or more have "thought of the same thing at the same time." The stimulus of the inventor's creative thought seems to permeate and fructify the mental processes of those about him. It being usually impossible for an inventor to personally carry out all the details of his invention, it is inevitable that his associates who further and develop his ideas shall produce creations having the attributes of invention, but it is fair to conjecture as to the extent of their progress, had he not imparted the first impulse by his primary inventive act. This view is recognized by the courts, and such inventions, termed ancillary inventions, are considered as having been engendered by the parent conception or stimulated by concordant effort on the part of associates or of others operating under the inventor's supervision. Being, therefore, considered a part of the parent invention, they are deemed to belong to the inventor himself so far as title to inventorship is concerned, and the right to subscribe its inventor to the patent applications.[5]

This is manifestly fair, for otherwise an inventor would be at the mercy of the cupidity and covetousness of unfair and mercenary associates. Without such consideration for the inventor's rights, he would be obliged to dispense with associates, and the delay entailed by his efforts to personally and alone work out an invention in all its details would defeat the spirit and purpose of the patent establishment, *viz.:* prompt public disclosure for advantage to industrial advancement. Care should be exercised, however, to distinguish between primary and ancillary invention. Unless the individual who devises an improvement is distinctly associated with the development of the machine or invention to which his improvement pertains, the chances are that he himself is the inventor of the improvement devised and should subscribe to the patent application.

For example, a maker of milling machines has in hand the reconstruction of his index head. While he is developing a new construction, one of his milling machine operators who has no knowledge of the development work in process but who recognizes the deficiency of the existing index head, invents a new index head embodying the very ideas on which his employer is working. Assuming that the milling machine operator first conceives and completes his index head, he

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[2] Joliet Mfg. Co. vs. Dice I 11,649 (1883); "When a workman is hired to invent, the employer will own the inventions which fall within the scope of the contract, while the others will belong to the employe."—Robinson, Vol. 2, p. 637: "If he (the employer) contracts for his employe's inventive skill, for its exercise in his behalf, he may thereby become the equitable owner of the inventions which result, and be entitled to an assignment of the patents when they are obtained."

[3] Pressed Steel Car Co. vs. Hansen, 137 F 403: "An employer has no right to the patent for an invention made by an employe, in the absence of an express contract or agreement of specific employment to make the invention."—Agawam vs. Jordan, 74 U. S. 583,602; "No one is entitled to a patent for that which he did not invent, unless he can show a legal title to the same from the inventor or by operation of law."

[4] Robinson on Patents, § 394-1: Collar Co. vs. Van Deusen: "Evans, the assignor of the plaintiffs, was a manufacturer, and claimed to be the inventor, of paper collars. He * * * employed various paper-makers to experiment toward the production of such a paper as he required. As they presented to him, from time to time, the fruits of their experiments, he pointed out to them the particulars in which their papers were still deficient but gave them no information as to the ingredients to be used or the methods to be employed in arriving at the necessary results. It was held that he was neither the inventor of the paper finally produced, nor of the process by which it was made; that he had merely pointed out an end to be obtained, not the means of its attainment, and was not entitled to appropriate the discoveries of the paper-makers as his own invention."

[5] Robinson on Patents, § 414 Ref. Annin vs. Wrenn. "An employe hired to assist an inventor in making improvements and to use his inventive skill for that purpose cannot claim, hold or transfer to a person having knowledge of such contract, any invention so made against his employer, but the inventions are the property of the employer. and if patented by the employe, a bill to compel their conveyance will lie."—New England Motor Co. vs. B. F. Sturtevant Co., 140 F 866 (N. Y. 1905): "When an employe discloses an invention to his employer who reduced it to practice, the employer is nevertheless entitled to be considered the inventor, especially where he diligently files an application therefor."—Knag vs. Green, Official Gazette, Vol. 127, p. 1581: "Where one conceives the principle or plan of an invention and employs another to perfect the details and realize his conception, though the latter may make valuable improvements therein, such improved result belongs to the employer."—Official Gazette, Vol. 128, p. 3291: "Inventors are often compelled to have their conceptions embodied in construction by skilled mechanics or manufacturers, whose practical knowledge often enables them to suggest and make valuable improvements in simplifying and perfecting machines or devices. Those are things they are employed and paid to do."

alone is the inventor, and not only can he alone subscribe to the patent application as inventor, but unless he is under an appropriate contract or agreement, he is not bound to turn the invention over to his employer.

On the other hand, suppose the proprietor turns the matter of improvement over to an employe, but imparts no data other than a statement of the insufficiencies to be overcome; and further that whatever improvements made are the products of the employe's creative thought. Then the employe is the inventor, and he only can properly subscribe to the patent application; but inasmuch as he is specifically employed to do this work, he is bound and can be compelled to assign the patent to his employer.[2]

But again, suppose that besides the mere statement of insufficiency the proprietor perceives the general form which the improvements must assume and imparts these by sketches, notes or otherwise to the employe, then the latter's creations, even though they attain the dignity or possess attributes of invention, are only ancillary, and the employer properly subscribes to the patent application as inventor.[5]

* * *

DEVELOPMENT OF A HIGH-SPEED MILLING CUTTER WITH INSERTED BLADES.*

While during the last few years the milling machine has been developed for high power and speed, the milling cutter has not advanced as rapidly. The user is thus confronted by the unsatisfactory condition of having the output of his milling machine limited by cutters of inadequate capacity. This refers in particular to inserted blade cutters. In order to eliminate the faults existing in present designs of such

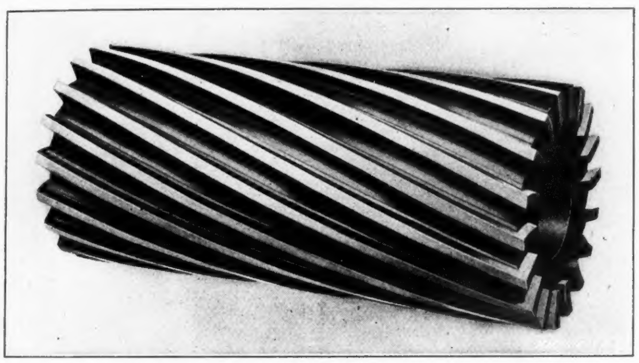


Fig. 1. Inserted Blade High-speed Milling Cutter with Helically-bent Blades.

cutters, and permit an increase in their capacity, the authors of the paper abstracted have developed a new design which will be described below.

Investigations showed that there was no existing standard governing the construction of inserted teeth milling cutters,

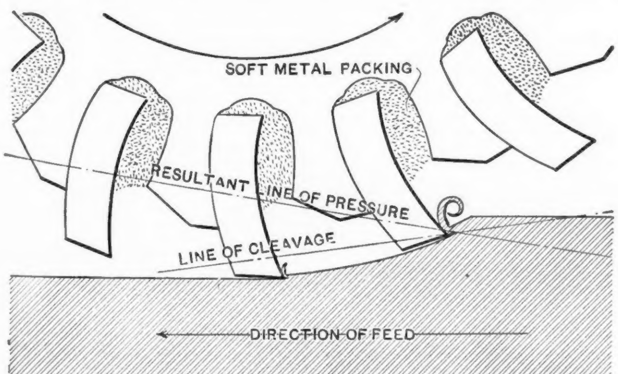
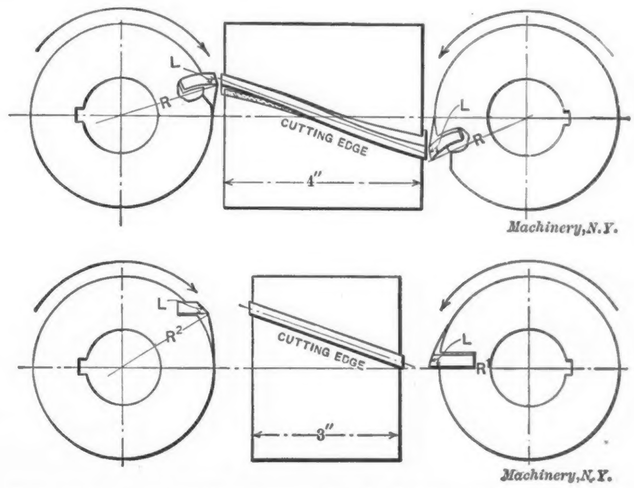


Fig. 2. Method of Inserting Blades in Cutter Body.

nor any record of exhaustive tests made for determining the most effective pitch, clearance angles, or front slope and lip angles to be employed. The first point considered in constructing the new cutter was, therefore, the shape of the blade, and the conclusion was arrived at that in order to maintain a prescribed slope and lip angle throughout the entire length of the blade, it must be bent to form a helix. On blades so shaped it is possible to provide a continuous cutting edge with a constant lip angle. The most effective angle of the lead or helix of the blade was found to be about 20 degrees. For facilitating computation a formula (diameter $\times$ 9 = pitch) was adopted, which gives 19 degrees 15 minutes as the angle of helix.

The next point to consider was the form of the grooves in the cutter body. Ordinarily these are planed approximately



Figs. 3 and 4. Comparison between Lip Angles obtained with Helically-bent Blades and Straight Blades.

rectangular in section with a slight amount of undercutting to hold the blade in place. It was conceived, however, that this grooving of the cutter body could be done better and faster by milling than by planing, and that an undercut groove might be produced at one setting by a saw set in a certain relation to the cutter blank. In order to form the blades accurately to the shape of the groove, it was necessary to design a bending machine of great power, capable of squeezing the blades at once to proper form, not only as regards the helix, but also as regards the correct curvature in a direction normal to the helix, the grooves being curved in this direction also.

The final point considered was the method of securing the blades. It was found that ordinary mechanical fastenings

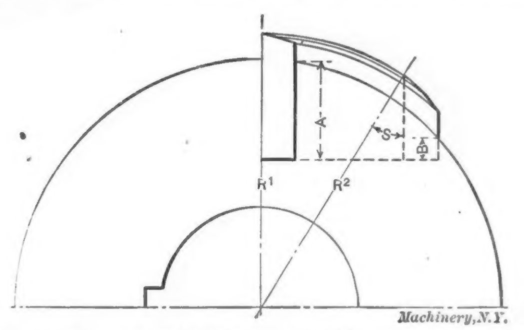


Fig. 5. Cutter with Straight Inserted Blade, seen from the End. Note changing Cutting Angle.

were not desirable both because of excessive cost and on account of inability to withstand vibration and remain rigid. Experiments were therefore made with various alloys until a proper combination was obtained, capable of flowing freely, of cooling without shrinkage, of withstanding great strains without crumbling, and of permitting quick removal of the blade.

A device was designed for compressing the alloy in the slot after it had been poured, and a device was also made for removing the alloy when replacing the blades. With the alloy compressed in the slots, the blades are so firmly secured that they may be broken off by force without affecting the binding qualities of the alloy.

The cutter developed along the lines outlined above is shown in Fig. 1. The claims made for this cutter are that it can be made of moderate diameter, although having inserted blades; that a greater number of blades may be provided than in regular cutters of this type; and that the cutter's capacity for removing metal is equal to the requirement of high power milling machines.

* Abstract of paper by Wilfred Lewis and Wm. H. Taylor, read before the American Society of Mechanical Engineers, December meeting, 1908.

The line engravings will give a clear idea of the actual construction of the cutter. Fig. 2 illustrates the form of the slot and blade, and shows also the space occupied by the binding alloy or "metal packing." Figs. 3 and 4 show the difference between the lip angles obtained with cutters made according to the principles laid down, with a helically-bent blade, and with cutters made with straight blades as is the common but objectionable practice. In Fig. 3 the angle is constant, no matter how long the blade, while in Fig. 4 the lip angle changes constantly from maximum at R_1 to minimum at R_2. In Fig. 5 the actual conditions of a cutter having straight inserted blades and seen from the end are still further exhibited. That the cutting action of such a cutter differs for every point on the blade is plainly in evidence.

RESULTS OF EXPERIMENTS WITH HIGH-SPEED MILLING CUTTERS WITH INSERTED HELICALLY-BENT BLADES.

Feed.		Depth of Cut, inches.	Width of Cut, inches.	Material Removed.			Duration of Test.		Speed of Cutter.		Electrical Readings.			Horse Power per cubic inch of Metal Removed.
Table Advance per minute, inches.	Advance per Blade, inches.			Cubic Inches per minute.	Pounds per minute.	Pounds per Hour.	Min.	Sec.	Revolutions per Minute.	Feet per Minute.	Ampere.	Volts.	H.P.	
11¼	0.01785	3/16	18	31.64	8.96	537.81	1	47	35	73⅛	190	220	56.03	1.77
11¼	0.01785	5/16	18	63.28	17.92	1075.62	0	11	35	73⅛	....	....	....	....
6⅜	0.01041	3/8	18	43.03	12.19	731.44	1	30	34	71	300	195	78.41	1 82
7	0.01080	3/8	18	47.25	13.38	801.15	1	26	36	75½	400 +	180	96.51	2 04
7	0.00925	3/8	18	47.25	13.38	801.15	2	51	42	88	370	187	92.74	1 96

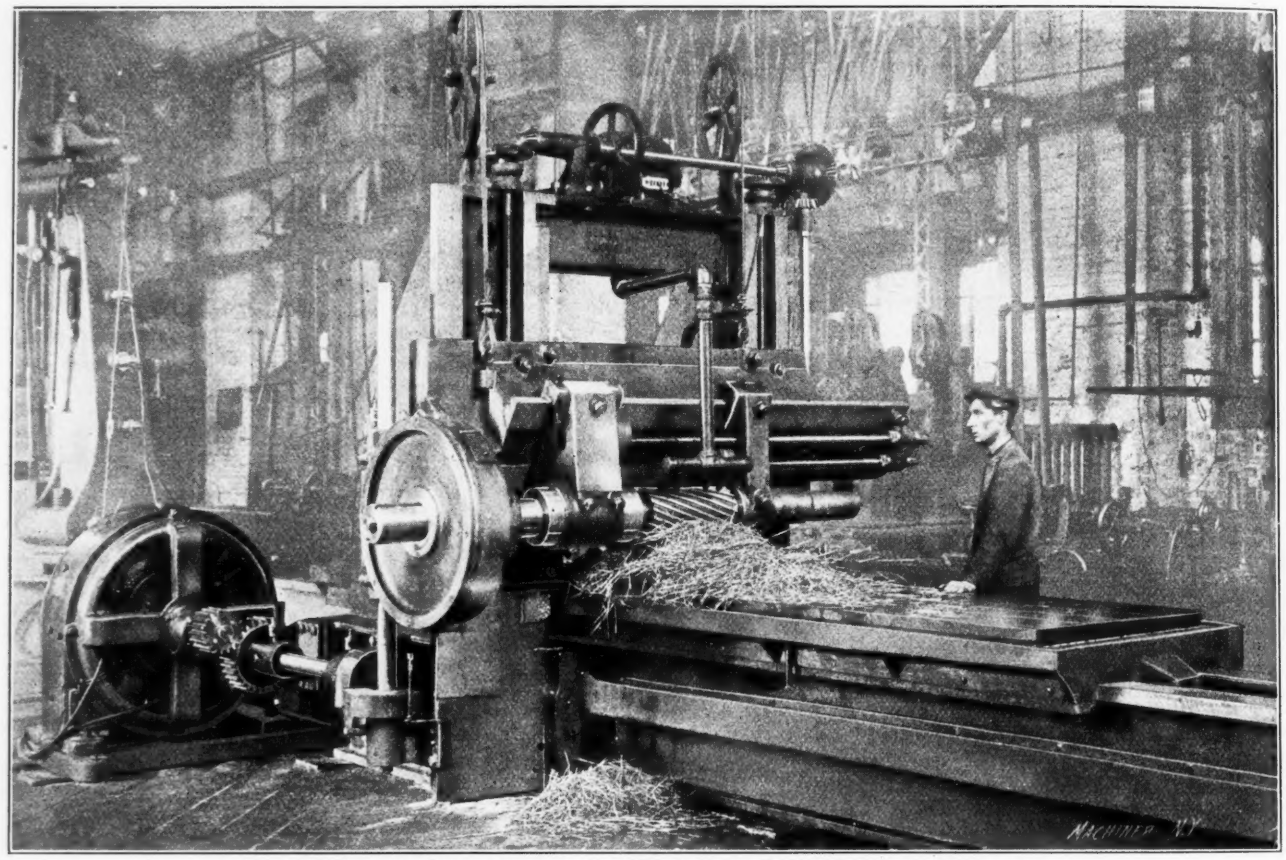


Fig. 6. High-speed Milling Cutter in use on High-power Milling Machine of the Planer Type.

Fig. 7 shows some of the chips cut by the cutter described, and in Fig. 6 the capacity of the cutter is well illustrated by the amount of chips removed by a single cut across the surface of the work.

In the paper under review, attention is called to the fact that experiments have conclusively demonstrated that nicking the blades of milling cutters does not constitute an altogether desirable feature. The part of the blade behind the nick which covers the gap formed by the nick in the blade preceding must take care of double the feed of the remainder of the tooth; this causes chatter and produces an uneven machined surface.

Much stress is laid on the use of lubrication during milling. A copious stream of lubricant falling at slow velocity should be thrown directly upon the chip at the point of removal. Heat generated by the pressure of the chip is the chief cause of wear; it softens the lip surface, causing it to crumble off. It was conclusively shown by experiments made that 33 per cent in cutting speed can be gained in milling steel and wrought iron, and 15 per cent in milling cast iron, by throwing a heavy stream of lubricant upon the cutter the entire length of its cutting edge.

A table is appended showing some of the actual results obtained in the experiments undertaken. The machine used in the experiments recorded was a 42-inch Bement-Miles mill-

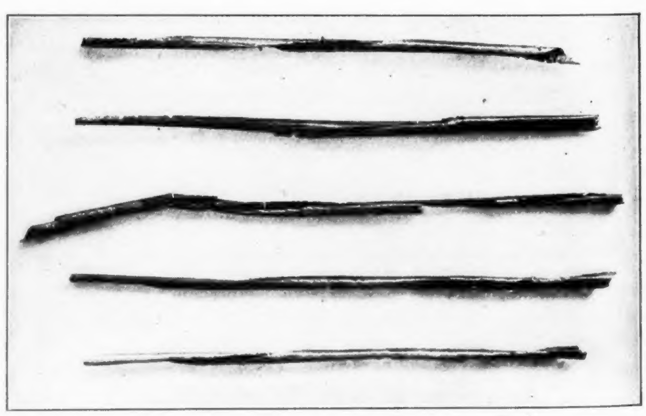


Fig. 7. Chips produced by the Cutter described.

ing machine, driven by a Westinghouse constant-speed 40 H.P. motor. The material cut was 30 per cent carbon steel. The cutter was 8 inches in diameter, 18 inches face, and of the type described.

KEYWAY GAGING IN SHAFTS AND HUBS.

Z. Y.

But little attention seems to have been given in the technical press to the gaging of keyways. The necessity for this work being inspected and gaged led to the devising of the appliances illustrated and described in this article.

A standard size of key had been previously adopted for each shaft, of which particulars are given in Table II, the key being square at the large end, and for shafts from $\frac{3}{8}$ inch to 2 inches, inclusive, advancing by even eighths, the key was one-fourth the diameter of the shaft. Reference to the table will give the other dimensions, but it may be noticed that the depth of the key in the shaft was to be half the width of the key, this depth to be taken at the edge of the groove.

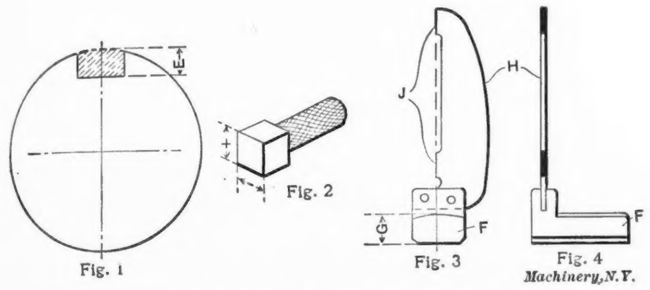


Fig. 1. Undesirable Method of Gaging Keyway Depth. Fig. 2. Limit Gage for Width of Keyway. Figs. 3 and 4. Gage used in Conjunction with Center-head, Fig. 5, for Determining Depth of Keyway and Parallelism of Sides with Radial Line through its Center.

After these points had been decided, the question arose as to the best way to indicate these dimensions on the drawings and how to measure the finished work.

With regard to the shafts, it would be an easy matter, with a micrometer depth-gage or other means, to measure the depth of the groove from the full diameter of the shaft, as at E in Fig. 1; but there was an objection to this, *viz.*, the difference there might be between the diameter of the shaft and the bore of the hub, although both were nominally the same diameter; for if the diameter of the shaft varied say by 0.002 inch or 0.003 inch, then this variation would also become apparent in the space available for the key, when assembled. The same argument applies to hubs, and on this account the

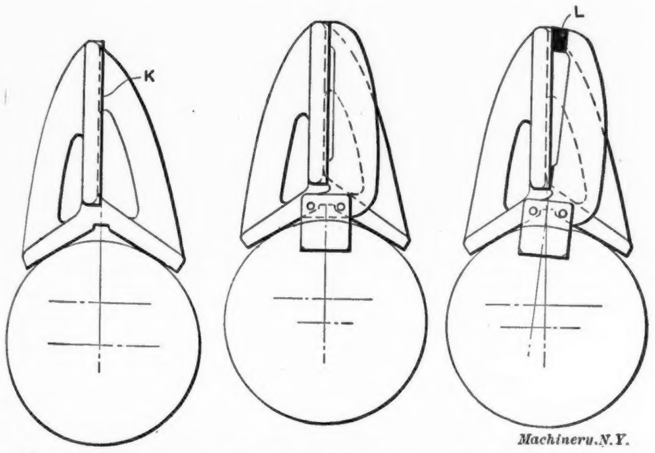


Fig. 5. Center-head used with Gage shown in Figs. 3 and 4. Fig. 6. Keyway with Sides Parallel with Radial Line through its Center. Fig. 7. Keyway with Sides not Parallel with Radial Line through its Center.

method of dimensioning as shown in Table II was adopted, which was to measure what remains of the shaft after cutting the keyway, and to measure the keyway across the bore in the case of hubs, this latter measurement being taken at the deep end of the groove. If the keyways are correctly cut in accordance with these rules, then the dimension B subtracted from the dimension A should equal the thickness of the key at a certain predetermined distance from the head. The advantage of this system of measuring the depth of a keyway is apparent, for, as has been explained, the keyway space will not vary even though there be slight variations in the diameter of the shaft or bore of the hub, providing, of course, the work of cutting the keyways is done accurately; consequently, the time spent in fitting keys can be reduced to a minimum as they can be machined practically to a finished size.

The permanence and stability of wheels upon their shafts depends very largely upon the fitting of the keys in their keyways, and this fitting, in turn, depends upon the keyway itself. If, for example, the keyway in the shaft is not parallel with the shaft's axis, or if the sides of the keyway are not parallel with a radial line passing through its center, the key, though it may seem tight enough when it is first driven in, will have such a poor bearing that the wheel or pulley will soon work loose. Therefore it was deemed advisable to gage the keyways in both shaft and hub as outlined in Table I.

TABLE I.

For Shafts.	For Hubs.
(1) Width of groove.	(5) Width of groove.
(2) Depth of groove.	(6) Depth of groove.
(3) If sides are parallel with a radial line through center.	(7) If sides are parallel with a radial line through center.
(4) If groove is parallel with axis of shaft.	(8) If parallel with axis of hub.
	(9) Angle of taper at the bottom of the groove.

Quite a number of gages of different kinds were considered which would properly gage one or more of the points required, but those considered best for the various purposes are those

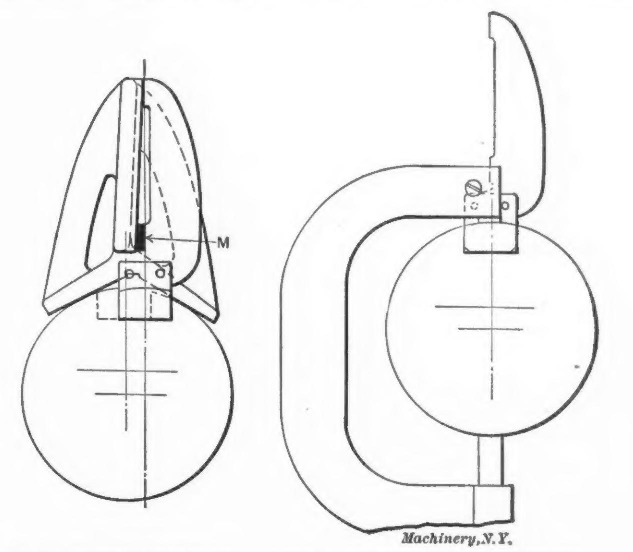
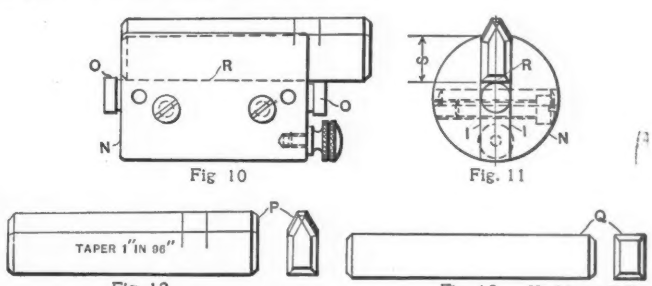


Fig. 8. Keyway not Parallel with Axis of Shaft. Fig. 9. Testing Depth of Keyway.

shown in the following: Commencing with the gaging of the shafts, and taken in the same order as tabulated in Table I, the following were the methods adopted:

Gaging the Shaft.

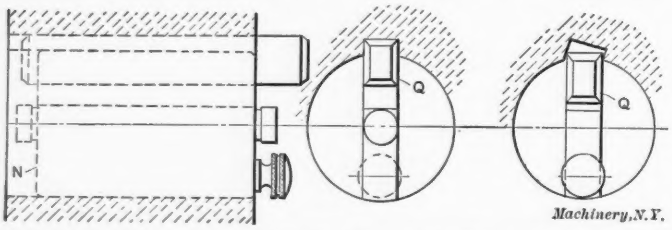
1. Width of groove. This did not call for any special gages other than those in use, an ordinary rectangular limit gage as Fig. 2 being quite suitable.



Figs. 10, 11, 12 and 13. Gages for Testing Depth, Parallelism of Sides with Radial Line through Center, Parallelism with Axis, and Taper of Keyway in Hub.

2, 3, and 4. The device used for (2) was also used for (3) and (4), and can best be described by reference to the illustrations. Fig. 3 shows an end view and Fig. 4 a side view of one of the gages, one such gage being required for each different width of groove. They are used in conjunction with the center-head, Fig. 5. The block F is a steel key, hardened and ground, the width being the same as the small width of

the limit gage Fig. 2. The length is twice the width, and the dimension G equals the nominal diameter of the shaft minus the figures in column B, Table II. Attached to one end of the key is the blade H, which is also hardened. After being attached to the base, the edge J was ground so that it was exactly central between, and parallel to, the sides of the key. The center-head, Fig. 5, is of cast iron, the V base being

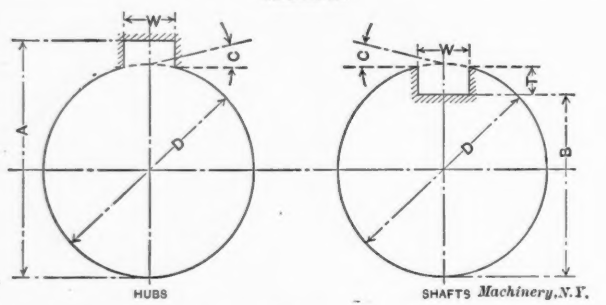


Figs. 14 and 15. Gage for Testing Keyway in Hub, and Exaggerated Illustration of Keyway which is not Parallel with a Radial Line passing through its Center.

finished to an angle of 120 degrees. The face K is carefully finished so that it lies in a plane bisecting the angular base, and therefore, when the base is placed on a shaft, the face K will always be in a plane passing through the center of the shaft.

Now, if when gaging a keyway it has been found correct for width, the gage Fig. 3 can be placed in the groove, and

TABLE II.



D = nominal diameter of shafts.

W = width of key $= \dfrac{D}{4}$ or nearest $\frac{1}{32}''$ less, up to and including $2\frac{1}{8}''$ or nearest $\frac{1}{16}''$ above $2\frac{1}{8}''$.

T = depth of groove measured at edge $= \dfrac{W}{2}$.

$C = D \times 0.0159$ when $W = \dfrac{D}{4}$.

Key groove in hub tapers 1 inch in 96 = $\frac{1}{8}''$ per foot.

A = depth of groove measured across bore at wide end.

Key groove in shaft is uniform in depth.

D	A	B	W	T	D	A	B	W	T
$\frac{3}{8}$	0.409	0.322	$\frac{3}{32}$	$\frac{3}{64}$	$1\frac{5}{8}$	1.792	1.396	$\frac{13}{32}$	$\frac{13}{64}$
$\frac{7}{16}$	0.471	0.384	$\frac{3}{32}$	$\frac{3}{64}$	$1\frac{11}{16}$	1.854	1.458	$\frac{13}{32}$	$\frac{13}{64}$
$\frac{1}{2}$	0.548	0.430	$\frac{1}{8}$	$\frac{1}{16}$	$1\frac{3}{4}$	1.931	1.503	$\frac{7}{16}$	$\frac{7}{32}$
$\frac{9}{16}$	0.610	0.492	$\frac{1}{8}$	$\frac{1}{16}$	$1\frac{13}{16}$	1.993	1.566	$\frac{7}{16}$	$\frac{7}{32}$
$\frac{5}{8}$	0.686	0.538	$\frac{5}{32}$	$\frac{5}{64}$	$1\frac{7}{8}$	2.070	1.611	$\frac{15}{32}$	$\frac{15}{64}$
$\frac{11}{16}$	0.748	0.600	$\frac{5}{32}$	$\frac{5}{64}$	$1\frac{15}{16}$	2.131	1.673	$\frac{15}{32}$	$\frac{15}{64}$
$\frac{3}{4}$	0.825	0.644	$\frac{3}{16}$	$\frac{3}{32}$	2	2.208	1.718	$\frac{1}{2}$	$\frac{1}{4}$
$\frac{13}{16}$	0.887	0.707	$\frac{3}{16}$	$\frac{3}{32}$	$2\frac{1}{8}$	2.333	1.843	$\frac{1}{2}$	$\frac{1}{4}$
$\frac{7}{8}$	0.963	0.752	$\frac{7}{32}$	$\frac{7}{64}$	$2\frac{1}{4}$	2.485	1.933	$\frac{9}{16}$	$\frac{9}{32}$
$\frac{15}{16}$	1.025	0.814	$\frac{7}{32}$	$\frac{7}{64}$	$2\frac{3}{8}$	2.610	2.058	$\frac{9}{16}$	$\frac{9}{32}$
1	1.102	0.859	$\frac{1}{4}$	$\frac{1}{8}$	$2\frac{1}{2}$	2.763	2.148	$\frac{5}{8}$	$\frac{5}{16}$
$1\frac{1}{16}$	1.164	0.921	$\frac{1}{4}$	$\frac{1}{8}$	$2\frac{5}{8}$	2.888	2.273	$\frac{5}{8}$	$\frac{5}{16}$
$1\frac{1}{8}$	1.240	0.966	$\frac{9}{32}$	$\frac{9}{64}$	$2\frac{3}{4}$	3.040	2.363	$\frac{11}{16}$	$\frac{11}{32}$
$1\frac{3}{16}$	1.303	1.028	$\frac{9}{32}$	$\frac{9}{64}$	$2\frac{7}{8}$	3.165	2.488	$\frac{11}{16}$	$\frac{11}{32}$
$1\frac{1}{4}$	1.379	1.074	$\frac{5}{16}$	$\frac{5}{32}$	3	3.317	2.577	$\frac{3}{4}$	$\frac{3}{8}$
$1\frac{5}{16}$	1.442	1.136	$\frac{5}{16}$	$\frac{5}{32}$	$3\frac{1}{8}$	3.442	2.702	$\frac{3}{4}$	$\frac{3}{8}$
$1\frac{3}{8}$	1.518	1.1813	$\frac{11}{32}$	$\frac{11}{64}$	$3\frac{1}{4}$	3.596	2.794	$\frac{13}{16}$	$\frac{13}{32}$
$1\frac{7}{16}$	1.580	1.244	$\frac{11}{32}$	$\frac{11}{64}$	$3\frac{3}{8}$	3.721	2.920	$\frac{13}{16}$	$\frac{13}{32}$
$1\frac{1}{2}$	1.656	1.288	$\frac{3}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$	3.872	3.007	$\frac{7}{8}$	$\frac{7}{16}$
$1\frac{9}{16}$	1.719	1.351	$\frac{3}{8}$	$\frac{3}{16}$	...	.....	.....	..	..

by placing the center-head on the shaft, and bringing it up against the blade, it can be seen at once if the groove is correct, for, if it is, the edges J and K will coincide as in Fig. 6. If the gages are used at both ends of the groove, the gaging can be done for both (3) and (4); for, should the groove be correct at one end, but not parallel with the axis of the shaft, the gaging will indicate, as shown exaggerated in Fig. 8. If the sides of the groove are not cut parallel with a radial line, but the groove is parallel with the axis of the shaft, the gaging will show as in Figs. 7 or 8 at both ends of the groove. By using feelers at L or M, any inaccuracy can be measured, and if this is found to be within the limits allowed, it then remains to gage for (2). This is done by using the gage Fig. 3, and measuring the diameter of the shaft by micrometer in combination with the gage, as in Fig. 9. If the depth of the groove is correct, the resulting dimension should equal the nominal diameter of the shaft.

Gaging Grooves in Hubs.

5. Width of Groove. As in the case of shafts, the limit gage, Fig. 2, is used.

6, 7, 8 and 9. For these steps the gages Figs. 10, 11, 12, and 13 are used. These consist of plugs N and two keys P and Q. These plugs were made up of three main parts each and hardened and ground on the faces before finally assembling, the face R being ground parallel to the center of the plug, and the width between the jaws being the same as the small width of the limit gage Fig. 2. The bosses O, at the end of the center part, are ground to this size, and then the faces I and R ground to these bosses. After assembling, the outside diameter is ground to the small end of the cylindrical limit gages in general use. One such plug is required for each different bore. The keys P and Q are also of steel, hardened and ground, and are a good sliding fit between the jaws of their respective plugs. The sides of the key Q are parallel to each other, and are slightly less than S in Fig. 11. The key P had its edges ground so that the angle between them was the same angle as the keyway taper, *viz.*, 1 in 96, or ⅛ inch per foot.

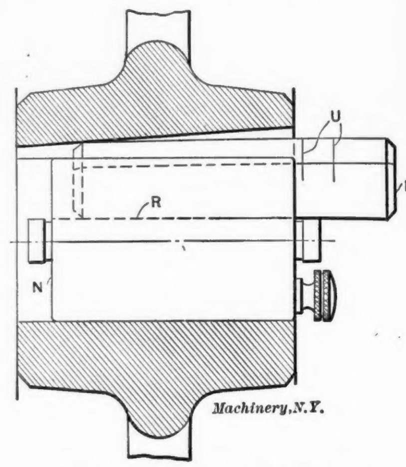


Fig. 16 Testing Angle of the Taper.

For gaging a keyway in a hub, if it has been found correct for width, the plug N can be placed in the bore, and if the groove is correct for (7) and (8) the key Q will freely pass out of the plug jaw into the groove in the hub, as in Fig. 14; but if incorrectly cut, then the key cannot enter to the full depth in the groove in the hub, this being shown exaggerated in Fig. 15. Of course it is possible for the groove to be apparently correct for (7) at one end of the bore, but if not correct for (8), it will be impossible to enter key Q. If the groove is correct for (7) and (8), then for the angle of taper (9) and depth of groove (6) the key P is used in a similar manner to key Q. By making this key separate from the plug, it is easy to feel if the groove is the correct taper on the bottom, for if the angle to which the groove has been cut is too great, the key will touch at its small end as in Fig. 16, or *vice versa*, a slight difference being easily felt. By making marks on the key P, as at U, any desired limits for (6) can be set.

* * *

An interesting method of insulating wire is mentioned in the *Brass World*. Some metallic oxides such, for instance, as the oxide of chromium, are insulators. Use is made of this fact in making and using resistance wire, containing nickel, iron manganese and chromium. The wire is heated, and an oxide forms on the surface, consisting of a mixture of all the metals. If treated with sulphuric acid, all the oxides, except the chromium oxide, are dissolved, and in this way a film of chromium oxide is obtained on the wire, which acts as an insulator.

* * *

Good enough is the deadly enemy of best.—*Speed.*

JIGS AND FIXTURES—9.

EINAR MORIN.*

EXAMPLES OF CLOSED OR BOX JIGS.

In the previous installment of this series, the development of a closed or box jig was treated. In the present installment a number of examples of closed jig designs will be shown and described. As was pointed out in the first installment in the April issue, when reference was made to different classes of jigs, there is no distinct division line between open and closed drill jigs, so that in many cases it is rather inconsistent to attempt to make any such distinction.

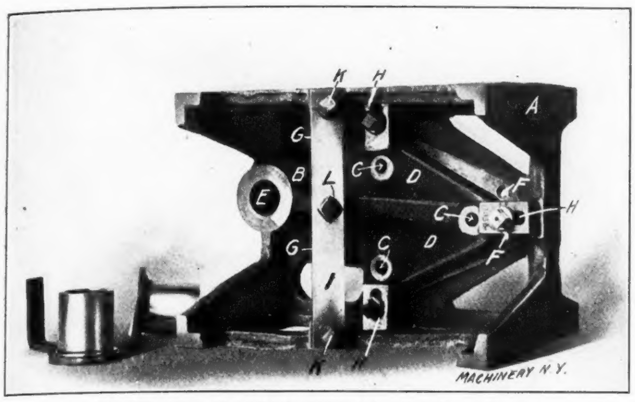


Fig. 97. Box Jig which Resembles the Open Type.

In Fig. 97, for instance, is shown a box jig which looks like a typical open jig. The jig body *A* is made in one solid piece, cored out as shown, in order to make it lighter. The piece to be drilled, *B*, shown inserted in the jig, has all its holes drilled in this jig, the holes being the screw holes *C*, the dowel pin holes *D*, and the large bearing hole *E*. The bosses of the three screw holes *C* are also faced on the top, and the bearing is faced on both sides while the work is held in the jig. The work is located against two dowel pins driven into the holes *F*, and against two lugs at *G*, not visible in the engraving, located on either side of the work. In these lugs are placed set-screws or adjustable sliding points such as described in the June issue. It may seem incorrect not to locate the bracket in regard to the hole *E* for the bearing, so as to be sure to bring the hole concentric with the outside of the boss. This ordinarily is a good rule to follow, but in this particular case it is essential that the screw holes be placed in a certain relation to the outline of the bracket in order to permit this to match up with the pad on the machine on which the bracket is used. Brackets of this shape may be cast very uniformly, so that locating them in the manner described will not seriously interfere with drilling the hole *E* approximately in the center of its boss. The work is firmly held in the jig by the three straps *H*, care being taken in designing the jig that these straps are placed so they will not interfere with the facing tool.

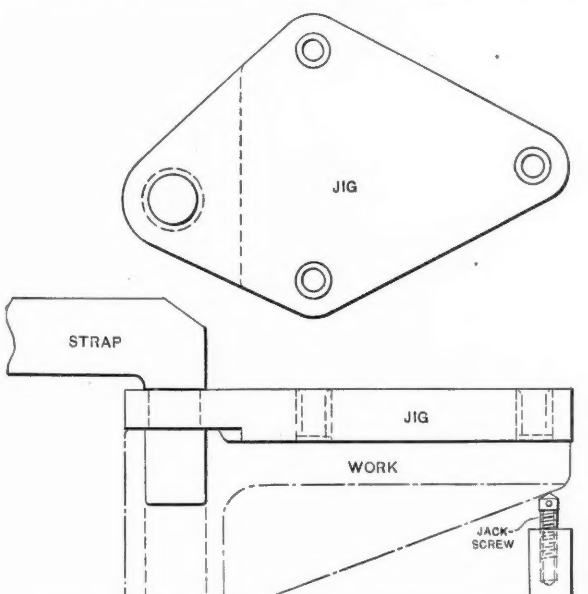


Fig. 98. Simple Form of Plate Jig for Drilling Bracket shown in Fig. 97, after Hole E has been bored in the Lathe.

The swinging strap *I*, which really is the only thing that makes this jig a closed jig, serves the sole purpose of taking the thrust of the heavy cutting tools when drilling the hole *E* and of steadying the work when facing off the two ends of the hub. The two collar-head screws *K* hold the strap to the jig body and the set-screw *L* bears against the work. This strap is easily swung out of the way simply by loosening one of the collar-head screws, a slot being milled at one end of the strap to permit this. Stationary bushings were used for the screw hole and dowel holes, but for the bearing hole *E* three loose bushings and a lining bushing are employed. The hole *E* is first opened up by a small twist drill, which makes the work considerably easier for the so-called rose-bit drill. The latter drill leaves 1/16 inch of stock for the rose reamer to remove, which produces a very smooth, straight and concentric hole. The last operation is the facing of the holes. The holes just drilled are now used to guide the pilots of the facing tools, and as the operation is performed while the work is held in the jig, it is important that the locating or strapping arrangements are not in the way.

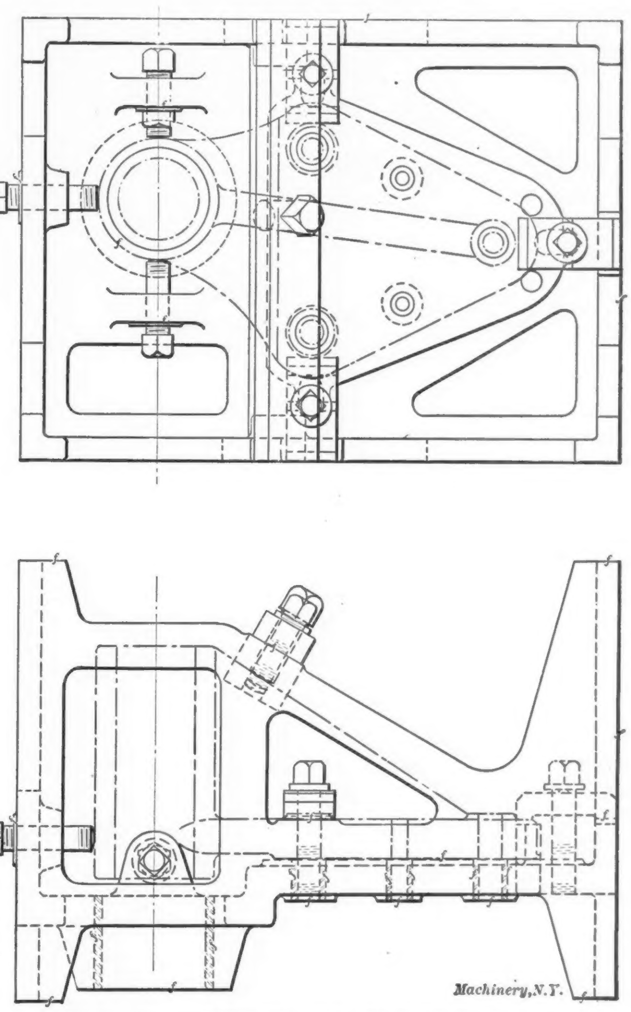


Fig. 99. Plan and Elevation of the Jig shown in Fig. 97.

In connection with the opening up of a hole with a smaller drill, it may be mentioned that it is not only for large holes that this method of procedure will save time, but even for smaller holes, down to ¼ inch in diameter, drilled in steel, time will be saved by opening up the hole with a still smaller drill.

The use of lubrication in jigs is a very important item, the most common lubricant being oil or vaseline, but also soap solution is used. The objection to the latter is that unless the machine and tools are carefully cleaned, it is likely to cause rusting. Using a lubricant freely will save the guiding arrangements, such as the drill bushings, the pilots on coun-

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terbores, etc., to a great extent. The line drawing of the jig in Fig. 97 is shown in Fig. 99 and a clear idea of the design of the jig will be had by studying this line engraving. The bracket *B*, in Fig. 97, could have been drilled in a different way than described, which will sometimes be an advantage. It could be held in a chuck, and the hole *E* reamed and faced in a lathe, which would insure that the hole would be per-

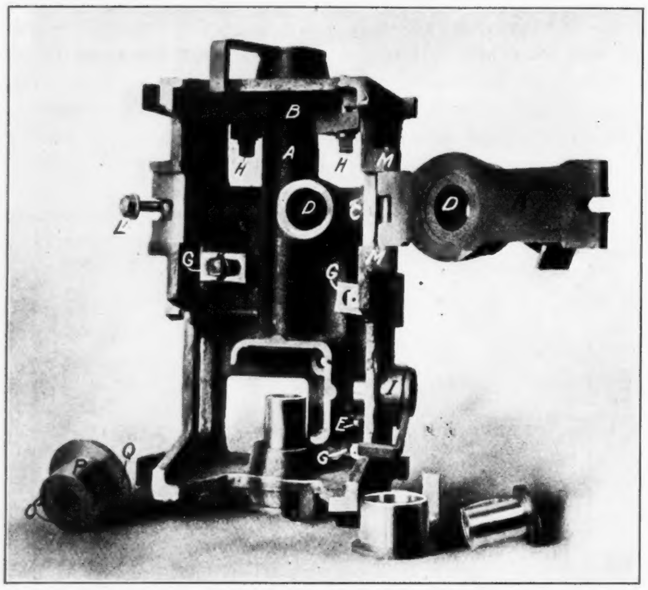


Fig. 100. Box Jig for Casing drilled from Five Directions.

fectly central with the outside of the boss. Then a jig could be designed, locating the work by a stud entering in hole *E*, as indicated in Fig. 98, additional dowel pins and set-screws being used for locating the piece sidewise. The whole arrangement could be held down to the table by a strap and bolt, a jack screw supporting it at the overhanging end.

Fig. 100 shows another jig of the closed type, with the work inserted. The piece *A* is a casing, and the holes to be drilled vary greatly in size. The casing rests on the flat,

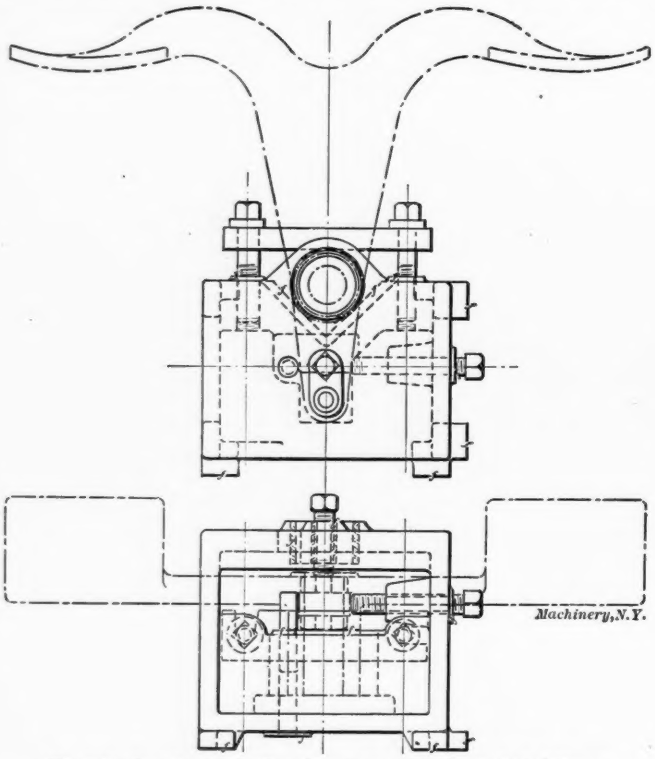


Fig. 101. Box Jig for Drilling Work shown in Dash-dotted Lines.

finished bottom surface of the jig and is brought up squarely against a finished pad at *B*. It further locates against the finished lug *C* in order to insure getting the proper amount of metal around the hole *D*. At the bottom it is located against the sliding point *E*, the latter being adjustable because the location of the work is determined by the other locating points and surfaces. The work is held against the locating points by the long set-screw shown to the left. This clamping arrangement, however, is not to be recommended because this screw must be screwed back a considerable distance in order to permit insertion and removal of the work. An eye-bolt used in the manner described in the installment in the August issue would have given better service. The three straps *G* hold the work against the bottom

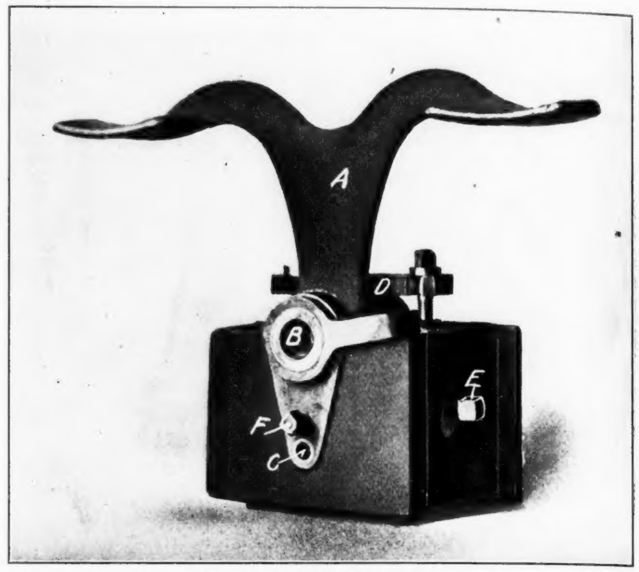


Fig. 102. Jig shown in Detail in Fig. 101.

surface, and the two straps *H* hold it against the finished surface at *B*. There is not a long finished hole through the casting, as would be assumed from its appearance, but simply a short bearing at each end, the remaining part of the hole being cored out. For this reason the hole is drilled and reamed instead of being bored out, as the latter operation would be a slower one. While the two short bearings are so far apart, the guiding bushings come so close to these bearings that the alignment can be made very good. The screw holes and dowel pin holes at the bottom of the casing are not shown in the half-tone, as the inserted casing is not yet drilled. The hole drilled from bushing *I* is a rather important hole, and the bushing required a long bearing in order to guide the drills straight when drilling. When this jig was made, the projecting lug which was provided solid with the jig body, to give a bearing to the jig bushing, came so

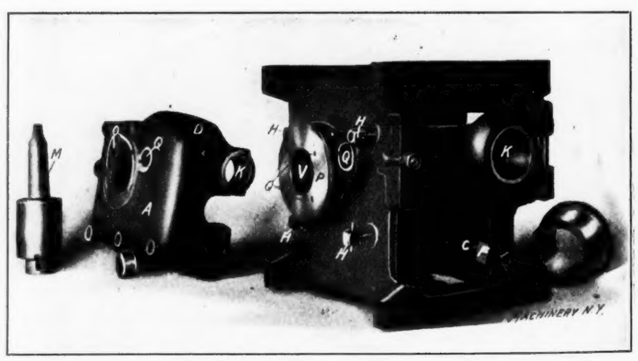


Fig. 103. Jig of Typical Design, and Work for which it is used.

much out of the way in the rough casting for the jig that half of the lining bushing would have been exposed. It was therefore planed off and a bushing of the type shown in Fig. 9 in the May installment inserted instead, in order to provide for a long bearing.

Leaf *K*, which carries the bushings for drilling the hole *D*, fits into a slot planed out in the jig body and is held down by the eye-bolt *L*. Two lugs *M* are provided on the main casting for holding the pin on which the leaf swivels, the construction being of the same type as illustrated in Fig. 50, July installment. Around the hole *D* there are three small tap holes *O* which are drilled by the guiding afforded by the bushing *P*, which is made of cast-iron and provided with small steel bushings placed inside as illustrated in Fig. 16, May installment. In the bushing *P* is another hole *Q* which

fits over a pin located in the top of the leaf and which insures that the three screw holes will come in the right position. It should be noted that large portions of the jig body are cored out at top and bottom in order to make it light and easy to handle. Of course some metal is also saved by the construction of jigs in this manner, but comparing the price of cast iron with the total price of a finished jig of this type, the saving in this respect is so insignificant that it is not

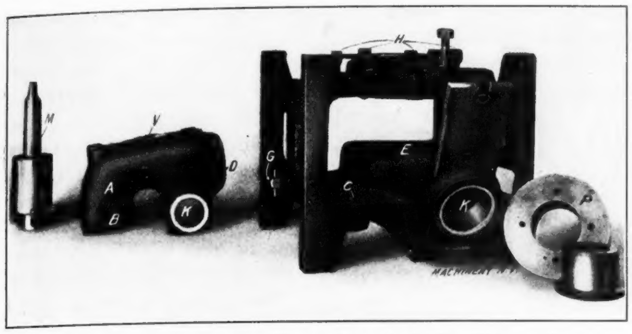
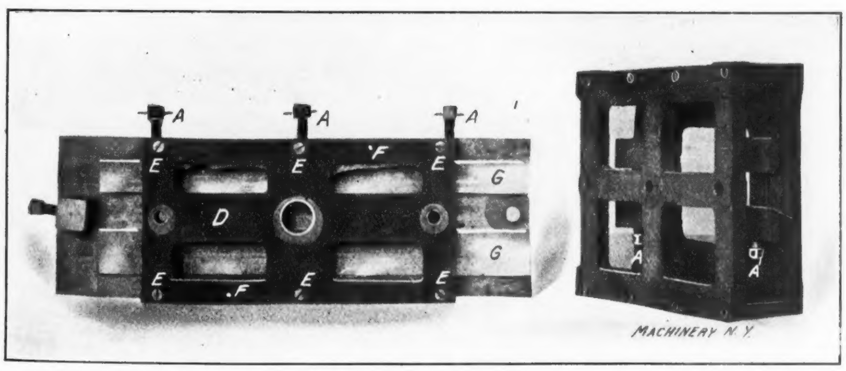


Fig. 104. Another View of the Jig in Fig. 103.

worth while mentioning. The leaf *K* is also made of cast iron, being of particularly large size, and it is planed at the places where it has a bearing on the jig body.

Fig. 102 shows a closed jig about which there can be no doubt that it should be classified as a box jig. The piece of work drilled, the foot trip *A*, has two holes *B* and *C* which are drilled in this jig. The cylindrical hub of the work is located against V-blocks and held in place by a swinging strap *D*. The work is further located against a stop pin placed opposite the set-screw *E*. The trip is located sidewise by being brought against another stop by the set-screw *F*. One-quarter of a turn of the collar-head screw on the top of the jig releases the swinging strap which is then turned out of the way; this permits the trip to be removed and another to be inserted. Half a turn or less of the set-screws is enough to release and clamp the work against the stops mentioned. A line engraving of this jig is shown in Fig. 101 which gives a better idea of some of the details of the construction.

In Figs. 103 and 104 are shown two views of another type of closed drill jig. The work *A*, to be drilled, is shown at the left in both illustrations, and consists of a special lathe apron with large bearing holes, screw holes, and dowel pin holes to be drilled. The apron is located in the jig column in the same manner as it is located on the lathe carriage, in this



Figs. 105 and 106. Jigs in which the Work is Located by means of Beveled Surfaces.

case by a tongue which may be seen at *B* in Fig. 104. This tongue fits into the slot *C* in the jig, care being taken in the construction of the jig that the slot is deep enough so as to prevent the tongue from bearing in the bottom of the slot. A good solid bearing should be provided, however, for the finished surface on both sides of the tongue. The surface *D* should also have a solid bearing on the surface *E* in the jig, the difference in height between the two bearing surfaces in the jig being exactly the same as between the two bearing surfaces on the lathe carriage where a lathe apron is to be fitted. The work is brought up against, and further located by a dowel pin at the further end of the slot by the set-screw in the block *F*, Fig. 103. As it is rather difficult to get the tongues on all the pieces exactly the correct width for a good fit in the slot, this latter is sometimes planed a little wider and the tongue is brought up against one side of the slot by set-screws. In the case in hand, a few thousandths inch clearance is provided in the slot and the set-screw *G* in Fig. 104 is used for bringing the work against the further edge which stands in correct relation to the holes to be drilled. The apron is held down against the bottom surface of the jig by four heavy set-screws *H*.

It will be noticed that the jig is open right through the sides in order to facilitate the finishing of the pads at the ends of the work, and a swinging leaf like the one previously described, reaches across one side for holding the lining and loose bushings for the hole *K* which is drilled and rose-reamed in the usual way. The large hole *V*, Fig. 103, is bored out with a special boring tool *M*, as there are no standard drills obtainable for this large size of hole. This special boring tool is guided by a cast iron bushing which fits into the lining bushing; it is provided with two cutters, one for roughing and one for finishing. The small screw holes *O* around the large hole *V* are drilled from the bushing *P*. For drilling

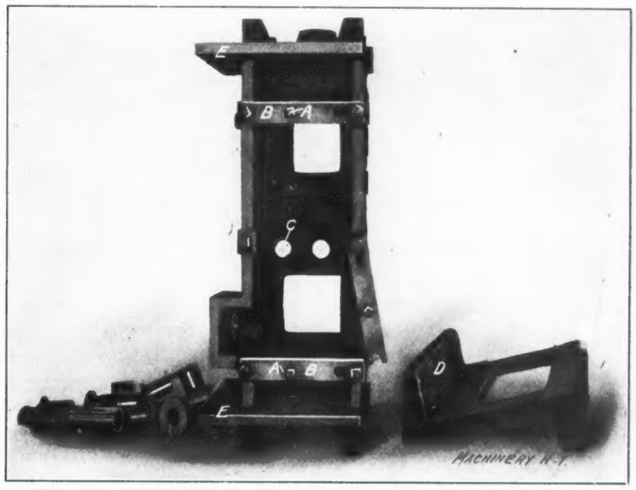


Fig. 107. Jig for Drilling Holes at other than 90-degree Angles.

the rest of the holes, except the hole *Q*, stationary bushings are used. The screw holes ought to be drilled simultaneously in a multiple spindle drill. The jig is provided with feet and cored out in convenient places in order to make it as light as possible to handle. Lugs project wherever necessary to give ample bearings to the lining bushings and, in turn, to the loose guiding bushings.

Figs. 105 and 106 show two closed jigs made up of two main parts which are planed and assembled by screws and dowels as indicated, the reason for making the jigs in this way being the ease of planing the bottom section. The work drilled in these jigs, some special slides, is located by the dove-tail and held up against one dove-tail side by set-screws *A*, as shown in both illustrations. In Fig. 105 the work is located endwise against a dowel pin and is held up against this stop by a set-screw through the block shown to the left. This block must be taken out when the slide is inserted, this being the reason why a lug cast directly in place, through which the set-screw could pass, is not used. The top plate *D* is held down on the main body by six fillister-head screws *E*, and two dowel pins *F* to prevent it from shifting. No clamping arrangements, except the set-screws *A*, are necessary. The holes being drilled from the top, the main body of the jig takes the thrust. These jigs are also used in multiple spindle drills.

One objectionable feature of the jig in Fig. 106 is that set-screws *A* are difficult of access. There are, therefore, holes piercing the heads of the set-screws in two directions in order to allow a pin to be used when tightening the screws. A better idea, however, would be to have the screw heads extend out through the wall, and if this were solid, to have cored or

drilled holes to permit the heads of the screws to pass through.

In Fig. 107 is another closed drill jig in which the work is located against the finished seats and held down by the set-screws *A* in the straps *B*. All the holes, except the holes marked *C*, are drilled in the usual manner, the jig standing on its own feet, but when drilling the holes *C*, which come on an angle, the special stand *D* is employed which brings the holes in the right position for drilling, as illustrated in Fig. 108. If only the holes *C* were to be drilled, the

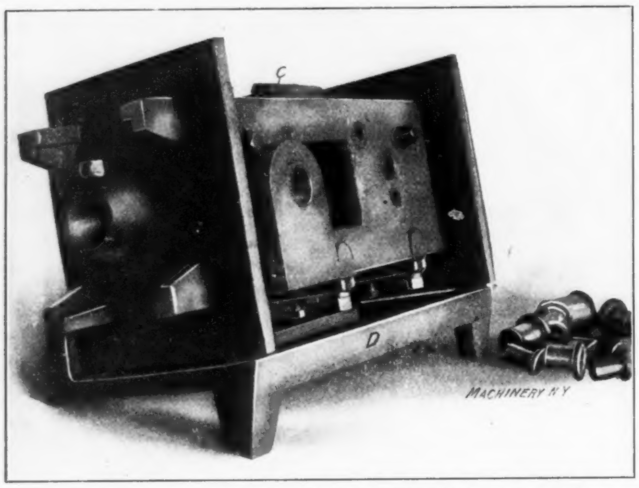


Fig. 108. Jig in Fig. 107 in Position for Drilling Holes at an Oblique Angle with the rest.

feet on the side opposite the guiding bushing for these holes could have been planed off, so that they would have been in a plane perpendicular to the axis of the holes. The principles determining the design of jigs of this type were outlined in the November issue. This last jig has a peculiar apperance on account of the end walls coming up square, as shown in the illustrations, but this design was adopted only to simplify matters for the patternmaker, it being easier to make up the pattern this way.

* * *

The great improvement in mechanical construction made possible by alloy steels is startling to those even who are most familiar with their characteristics. For example, modern ordnance which hurls a 12-inch shell at an initial velocity of 2,500 feet per second, is only made possible with carbon steels by adopting the built-up structure by which one tube is shrunk upon another until the core is put into a state of compression nearly equal to the tensile stress that will be exerted upon it by the explosion of the powder charge. The elastic limit of ordinary steel is too low to resist the great pressure, and the layers of steel next to the powder chamber of a single-tube gun would be stretched more and more with each succeeding explosion until the piece burst. The built-up structure distributes the internal pressure more or less equally throughout the barrel and thus enables it to withstand an indefinite number of firings. But high-grade alloy steels may enable us to revert to the simple tube forms again for heavy guns. A gun tube used in the Davis double torpedo made of vanadium steel one inch thick and weighing only 350 pounds, successfully withstands a powder charge sufficient to propel a 10-inch shell with a velocity of 1,100 feet per second!

* * *

The recent sale of 2,000 practically unused breech-loading Springfield muskets for 69 cents apiece by a New York department store is a good example of the enormous waste of war and preparation for war. These weapons cost the United States Government $18 each, and for years were considered to be the best army gun in the world, but the rapid improvements in shoulder arms during the past fifteen years have made the model obsolete, as well as several others that followed it. Thousands of obsolete arms are sold at auction by the governments of the world every year for little more than their value as old metal, but still the armories go on year after year turning out new models at tremendous cost—for what?

GRINDER KINKS.

PAUL W. ABBOTT.*

The following article will deal with some of the kinks used in our tool-room by the tool grinders, some I have seen around the shop, and others which I have used myself. They are all good, practical kinks which are in use every day.

Fig. 1 is a hand grinding rest which is very handy for use on the universal grinder. It is adjustable up and down for height, and is used for hand grinding circular and straight form tools, sharpening metal slotting saws, formed cutters, etc. Fig. 3 shows the application of the hand rest to the grinding of saw teeth in a blank. The tooth rest used in connection with this operation is shown in Fig. 2. These saws are first ground on an arbor, the old teeth being ground off, leaving a perfect circle. The operator then puts on this device, setting the tooth rest so that the teeth will be about ¼ inch apart, and grinds around by hand, not quite bringing each tooth to a sharp point. On the last nine or ten teeth he evens up any inaccuracy in the spacing, the wheel being trued off to the exact shape of tooth space wanted.

Fig. 4 shows a device for accurately sharpening formed cutters up to 3 inches diameter, which is used when the cutter grinder has another job in it, or could be used to advantage where there was no surface or cutter grinder. The device consists of the cast iron slide *B*, at the end of which is a tapped hole *C*, with a small fillister head screw which holds the various sizes of bushings which fit the holes in the cutters. On the same end is the index pin *D*, which is adjustable back and forth. In operation, the hand rest shown in Fig. 1 is also used, and the pins *A* are lined up parallel with the forward travel of the wheel and so that the cutting face of the wheel is on a line with the center of the bushing. The cutter is then slipped on over the bushing and the index pin is set so that the required amount will be ground from the face of the tooth. The operator brings the wheel up to the proper position and then pushes the slide forward until the wheel has reached the bottom of the tooth space; he then withdraws the slide and indexes to the next tooth, and so on, tooth after tooth. It will be noticed that the index pin rests against the back of the tooth, which means that upon the previous milling of the teeth depends the accuracy of the grinding; but on the standard cutters furnished by numerous concerns this spacing will be found accurate enough.

Fig. 5 is a center for the head-stock for holding small forming tools of odd size, or threaded pieces which are to be ground on the periphery. The tools are simply clamped to the face of the center, and trued up by an indicator. Fig. 6 is a device for grinding snap gages for the tool grinder, where there is no surface grinder for this class of work. The shank of this device is made to fit the head-stock, and the gages are clamped to it by a small strap and two screws. This fixture revolves while in use, and the jaws of the gage are ground by feeding a thin wheel in and out by hand. Revolving the device insures perfectly straight gage faces. Fig. 7 shows a center for the universal grinder for holding a standard line of large end milling cutters with threaded holes, while sharpening. The head-stock is swung around at right angles to the ways, and with a long support for the tooth rest (Fig. 8), which is bolted to the platen, the cutters are ground very handily by throwing in the feed and grinding one tooth, and then, before the wheel comes back, indexing to the next tooth, and so on.

Fig. 9 shows a hardened roll which is ground all over, and Fig. 10 the fixture for the universal grinder for grinding the sides of this roll. This plate was made of cast iron, with both sides ground and with each hole ground to 0.0005 inch over standard size. Each hole has a ¼ inch set-screw, as shown at *A*. In operation, the plate is fastened to the face-plate by a draw-back rod, and the head-stock is swung around at right angles. As the plate revolves, 16 rolls are ground at once; first on one side, and then the plate is turned and the other side ground, the rolls being made to standard length by using a depth gage. The hardened roll shown in Fig. 11, which is used on swaging machines, is held by the centers shown in Figs. 12 and 13, when being ground. Fig. 12 is

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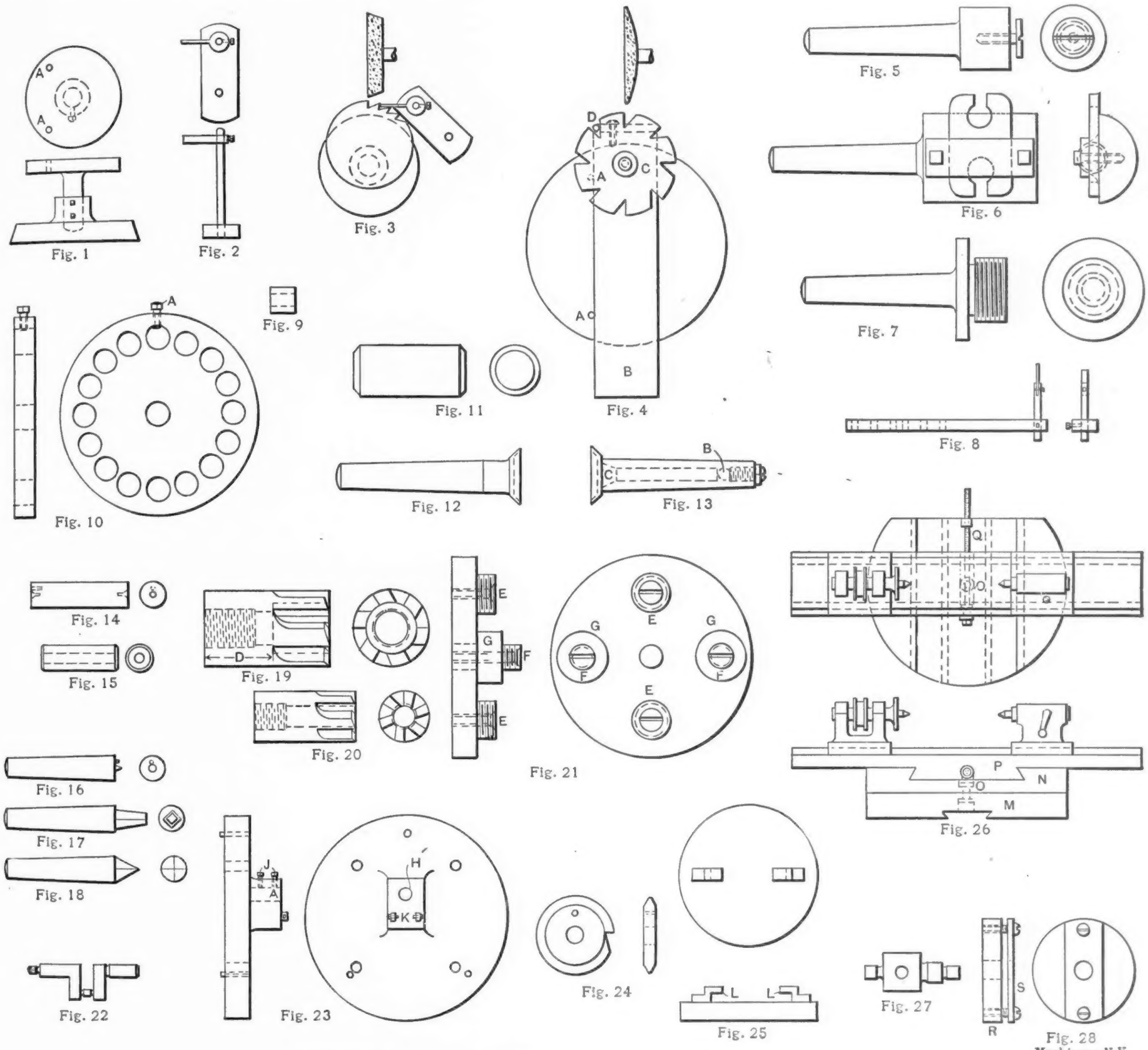
the head-stock center cupped out on the end to fit the beveled end of the roll. This center drives the roll by friction, the pressure being obtained by the spring tail-stock. Fig. 13 is the tail-center which is in two parts, the inner spindle running with the roll and being adjusted by the screw in the end so that the thrust is taken by the ball *B*, the tapered portions *C* just clearing each other. Other methods of grinding rolls are shown in Figs. 14 to 18. One example of grinding is shown in Fig. 14, and its center in Fig. 16. The roll is driven by a pin on the center, which engages with a corresponding hole in the work. A better method, which I have used, is to center the roll and then in one end drive a square 60-degree punch, using the square center shown in Fig. 18 for driving the work while grinding. Another good method for hollow rolls, such as shown in Fig. 15, is to use a 15-degree square center, such as shown in Fig. 17, the end of which just enters the hole.

Figs. 19 and 20 show two end mills. The smaller one is fastened inside of the larger when in use, and when in position rests against the bottom of the hole and projects outside a definite distance. The length *D* is standard in all these mills. Fig. 21 shows the fixture for grinding two pair of these mills at a time, so that the same amount will be taken off of both the short and long ones. Threaded bushings *E* fit the larger size mills, and *F*, the smaller. The collars *G* are of such a thickness that the cutting face of the smaller mill is brought into the same plane as the larger, and so when grinding, an equal amount is removed from the face of each mill. The plate is held to the face-plate by a draw-back rod. The head-stock is swung at right angles, and with the fixture revolving, the wheel traverses back and forth across the faces of the mills. The mills are then taken to a cutter grinder and backed off.

Fig. 22 shows a small crank-shaft, and Fig. 23 the fixture for grinding the pin. The bearings are first ground on centers in the usual way. The fixture is of cast iron and is held to the face-plate by screws and dowel pins. In the making of this fixture the hole *H* was ground out to the size of the bearing, and then the fixture was correctly located and doweled to the regular face-plate. The crank, while being ground, is held by the set-screws *J*, and the screws *K* which are set against the crank on either side.



Various Tools and Fixtures for Miscellaneous Work on the Grinding Machine.

The grinding of formed cutters, similar to the one shown in Fig. 24, so that they will be interchangeable, is very interesting. The error limit is .00025 inch. The grinder used is a Norton universal tool and cutter grinder. After hardening, the cutters are first ground to a definite thickness. For this operation they are held against the face-plate by a draw-back chuck. The next operation is grinding the beveled sides, which is accomplished by holding the cutters against a small face-plate by a draw-back chuck. The correct angle of bevel is obtained with the protractor, and to get the correct diameter of the bevel sides, and to insure that the bevel sides stand exactly in the same relation to each other, the gage shown in Fig. 25 is used. This gage is hardened and ground all over, and the two gaging points *A* are set a predetermined distance apart and as near the same height from the platen as mechanical means can make them. It is ob-

vious that cutters which are all ground the same thickness, and which will pass through this gage with the beveled sides both touching the gage points with equal pressure, will interchange within pretty close limits. The operator grinds one bevel side at a time, trying the work every little while in this gage; when one side passes through the gage the cutter is turned around and the other bevel ground. For grinding the radius on the periphery and bringing the cutter to the correct diameter, the radius grinding fixture shown in Fig. 26 is used. The dovetailed base M is fitted to the platen of the grinder and upon this base is a sliding base N which is pivoted to M by a bolt O. Upon the base N there is an auxiliary platen P which can be adjusted back and forth by the screw Q for getting the proper radius. This auxiliary platen is made the same as the machine platen so that the regular head- and tail-stocks will go on it. A cutter is placed on a special arbor and the platen P adjusted to give the correct radius. The wheel is then brought up and the cutter is ground to the correct diameter, the curved face being obtained by swinging the base N back and forth by hand in an arc of a circle, with bolt O as a center.

Another ingenious scheme which I saw in the tool-room is shown in Fig. 28. The foreman brought along three or four pieces similar to the one shown in Fig. 27, and wanted the holes ground out. With an independent 4-jawed chuck this would have been easy, but there was no such chuck; and as there would never be any more of these pieces to be ground the fixture for doing the work had to be inexpensive. The face-plate could not be used as the pieces were smaller than the hole in the face-plate. The operator thought awhile, and then hunted around a few minutes and found a large washer R, tapped two holes in it, filed up the sheet steel strap S, and with a couple of machine screws was ready to begin. The washer was first put in the universal chuck and the outer side ground. One of the pieces was then clamped in place, and after putting on the internal grinding attachment it was ready to be ground.

* * *

"From standing grain in the field to well-baked biscuits in twenty-two minutes was the record made in converting the raw material into the manufactured product at Waitsburg, Washington, recently." The foregoing, quoted from a newspaper, "is important if true." It indicates to what remarkable degree the mechanical processes of harvesting and preparing cereals for food have been developed. The statement appears incredible, however, because at least fifteen minutes would be required for baking, leaving only seven minutes for harvesting, threshing, grinding and preparing for the oven.

THE APPLICATION OF AUTOGENOUS WELDING TO AUTOMOBILE REPAIRS.*

HENRY CAVE.†

In the October, 1908, issue of MACHINERY, the apparatus used for autogenous welding was illustrated, and the principles involved discussed. In the present article a few applications of autogenous welding will be treated, particularly with reference to automobile repairs. As was stated in the article referred to, the metal to be welded is melted by the acetylene gas, burning with pure oxygen, and at the point of fusion the metals flow together and are practically "re-cast" locally, material being added when necessary from a rod of the same metal as the parts being welded. This applies to all metals, including cast iron and aluminum. These latter are mentioned specifically, because they are not commonly considered as possible to weld, and therefore serve better as an example showing the possibilities of autogenous welding.

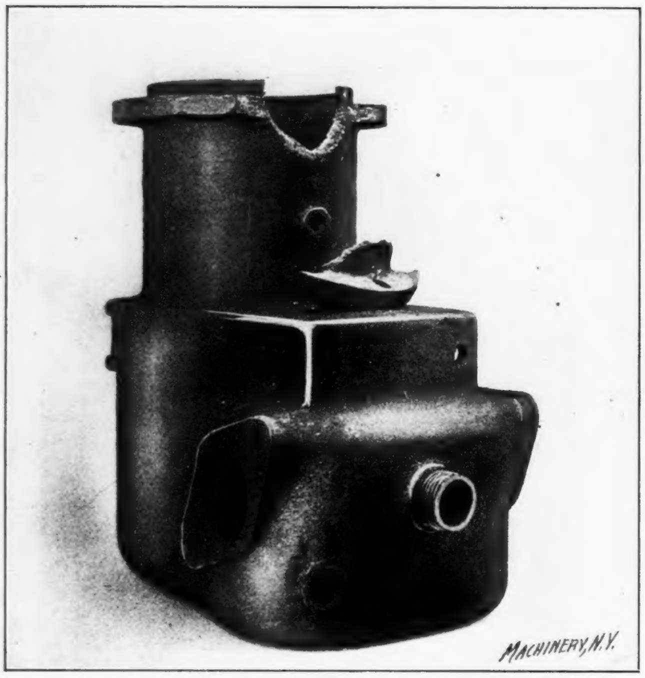


Fig. 1. Broken Cylinder to be repaired by Autogenous Welding.

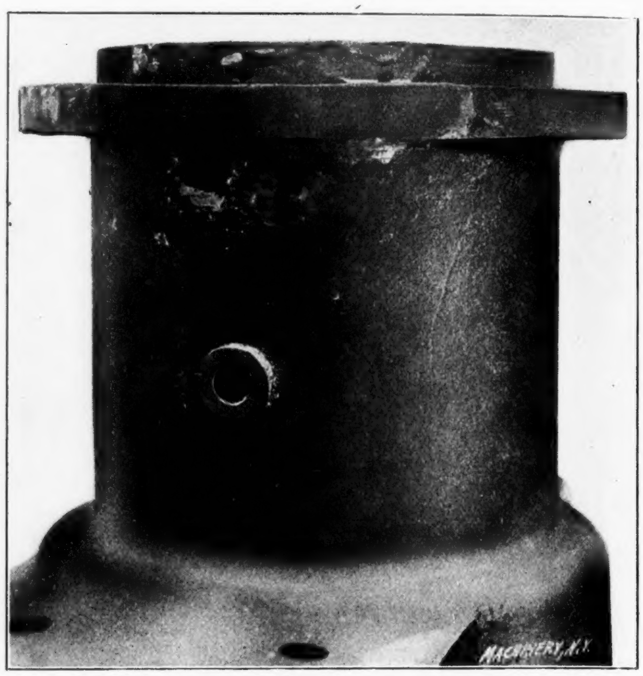
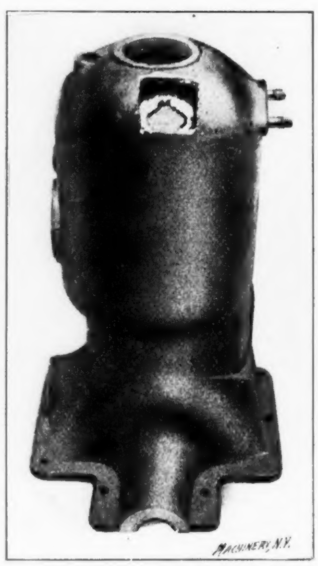


Fig. 2. Enlarged View of Cylinder in Fig. 1, showing Part repaired without Impairing Finished Surface on Inside.



Figs. 3 and 4. Water-jacket of Cylinder, repaired from the Outside by filling in Cavity against Graphite Backing on the Inside.

One of the first principles to be understood in regard to autogenous welding is that the flame must actually come in contact with every particle of the metal welded. It is impossible to weld in places where this cannot be done. For

* For additional information on this subject, see Oxy-Acetylene Process of Metal Cutting and Autogenous Welding, October, 1908, and other articles there referred to.

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instance, if a small boss is required on a casting, it is not possible to cut out a thin disk of metal of the size of the boss, with the idea of welding it onto the casting. In a case like this, the metal would be added drop by drop until the required size is reached, and if the boss must be machined to size, metal must be added for finishing. Metal up to one-eighth of an inch in thickness can be butt-welded. The heat passing down the opening is sufficient to insure a weld clear through the thickness of the metal. If the thickness

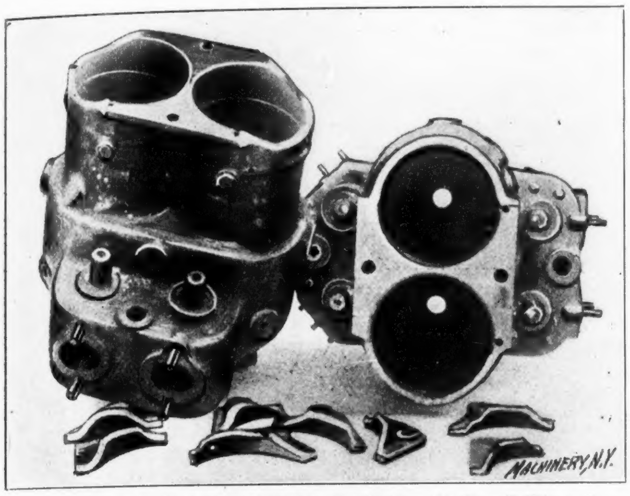

Fig. 5. A Badly-broken Casting, illustrating the Possibilities of Autogenous Welding.

is greater, the sides must be first beveled off, allowing the welding flame to penetrate to the bottom of the joint. The metal at the bottom will then first flow together, and the groove caused by the beveling must be filled up by adding metal of the same kind. The beveling or grooving is usually done by grinding, chipping or filing. When beveling a broken part, care should be taken to leave enough of the original break to line up the parts with. The best practice is to leave three short sections on each fragment for this purpose. It is evident, from what has been said, that it is not possible to make a lap-weld with this apparatus. Therefore, when it is required to weld such parts as are usually brazed, as for example the joints of the exhaust manifold for automobiles, which are made from steel tubing, it is necessary to fit the two tubes so they butt together, and they should not be flanged as for brazing. Flanges and other fittings are welded to the

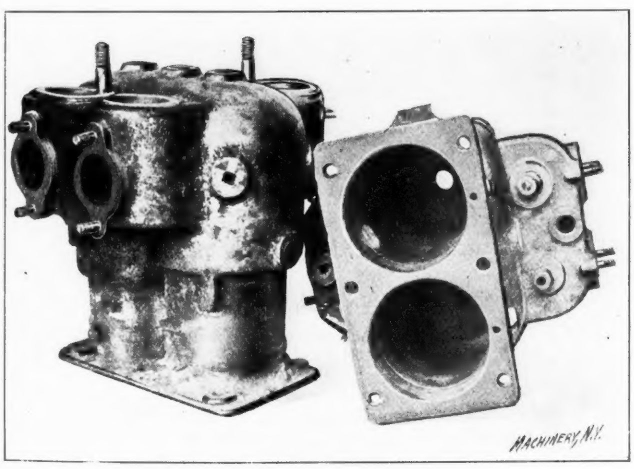

Fig. 6. Casting in Fig. 5 after having been repaired.

pipe only at the edge, either at the outside or inside, or both. It is necessary to weld around only at one place if the pipe is a good fit in the flange.

When a cut, crack or break passes through a machined surface as in the case of the cylinder, Figs. 1 and 2, and it is not necessary to eliminate all signs of the accident, the parts may be welded together entirely from the outside. The machined surface on the inside of the cylinder will not then be damaged, but the line of the crack can always be seen on the inside. If it is necessary to eliminate all signs of the break, then the crack must be welded on the machined side as well, and metal added which can be removed in remachining the parts.

It is sometimes impossible to gain access to both sides of a weld, as in the case of the two-cycle cylinder, Figs. 3 and 4. Then it will be necessary to make the weld entirely on the outside. In this particular case it is desirable that the inside be kept free from projections. To accomplish the repair in this case, a piece was therefore cut out of the jacket wall as shown in Fig. 3, and a block of graphite, which stands intense heat better than any other material, was fitted inside the cylinder. The weld was then made by filling in the hole, as shown in Fig. 4. When this was done, the graphite was removed, the inside surface being perfectly smooth. The outside of the cylinder in Fig. 4 can be trimmed off and finished, so that it will look the same as before the accident.

Figs. 5 and 6 illustrate a broken automobile cylinder successfully repaired. It will be seen from Fig. 5 that a great many parts are broken off and the repairing of this cylinder by welding gives a good illustration of the difficult class of repair work that can be carried out by the process. The illustrations show that autogenous welding can be extensively used, both in the manufacture of various kinds of machinery and in the repair shop. The saving of time which can be effected by quickly-made repairs, as compared with remaking castings, is plainly in evidence. The work illustrated in the accompanying engravings has been carried out at the demonstration plant of the Autogenous Welding Equipment Co., Springfield, Mass. It is likely that within comparatively few years the apparatus for carrying out autogenous welding will be recognized as part of the necessary equipment in any machine shop.

* * *

At the semi-annual meeting of the National Association of Cotton Manufacturers, at Saratoga Springs, N. Y., attention was called to the importance to manufacturers of reforestation. The president, Mr. Charles T. Plunkett, of Adams, Mass., in his address, touched on the subject, and afterwards several speakers in a discussion on the importance of forest preservation to manufacturers, voiced the opinion that the subject of forest preservation was of vital importance to everybody engaged in any kind of manufacture, and employing power. The energy stored up in our waterfalls will become comparatively useless if a fairly steady flow of water cannot be expected the year round. Reckless devastation of forests in the past and present makes it impossible to secure anything like an even flow in the streams of the country, and if the great amount of power that can be obtained from the waterfalls is not to be entirely lost in years to come, it is necessary that the hillsides should not be robbed of their natural capacity of acting as reservoirs for surplus water. Not only is this matter of importance from the point of view of power generation, but also on account of the destructive floods that of late have menaced many industrial properties in the country, along the banks of our larger rivers, most of which can be ascribed directly to the cause of permitting the regions along the upper course of the rivers to be stripped of their forests.

* * *

A special sub-committee of the British Society of Motor Manufacturers and Traders, has, as stated by the *Horseless Age*, evolved the following horse-power formula for gasoline engines:

$$\text{Horse-power} = KDN(D-1)(R+2),$$

in which formula,

K = a constant varying between 0.197 and 0.333,
D = the cylinder bore in inches,
R = the ratio of stroke to bore, and
N = the number of cylinders.

This formula, which is intended for use in connection with hill climbs and similar trials, takes into account that it is not possible to obtain as high mean pressures in large as in small engines, and also the ratio of bore to stroke. The source which we quote, unfortunately, does not give any information as to what conditions govern the selection of the value of the constant K.

WELDING.*

JAMES CRAN.†

Up to comparatively recent years, the only process of welding wrought iron and steel was to heat the parts to be welded in a forge or furnace until they had reached a semi-melting condition, after which they were united by hammering. At the present time there are several distinct processes which give the same, or in some cases, better results than are possible by the ordinary process mentioned. Among these may be mentioned the Thermit process (see MACHINERY, March, 1903), the electric welding process (see MACHINERY, April, 1908), and the autogenous welding process (see MACHINERY, October, 1908).

The first mention of welding by electricity, was made by James P. Joule, of Manchester, England, in a paper published in 1856. It was, however, more than thirty years later before electricity became used for welding in the mechanical arts. One feature of importance in relation to the electric welding is that it makes possible not only the welding of iron and steel, but of metal widely dissimilar, as high carbon to low carbon steel, brass or copper to iron or steel, etc. It is, however, the writer's intention to deal in the following principally with welding as it is, or rather as it should be, done at the forge. It is the oldest, the most common, and, perhaps, the least understood of the welding processes. It has not received the attention that its importance merits, nor has it improved with other mechanical arts.

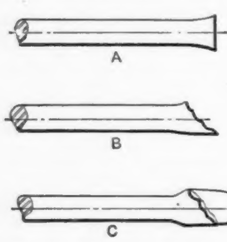

Fig. 1. Incorrect Upset and Scarfing for Plain Lap Welding.

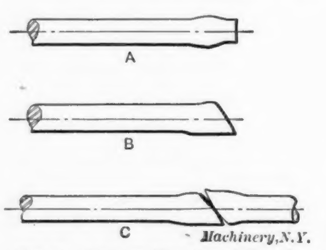

Fig 2. Correct Upset and Scarfing for Plain Lap Welding.

Brawn and muscle have generally been considered more essential to the blacksmith than brains, and thus the fact that preparing the pieces to be welded is of as much importance as the actual heating and hammering, is far too seldom taken into consideration. The preparation of work for welding depends greatly upon the shape of the forging and the class of work for which it is intended.

Plain Lap Weld.

The most common joint is the plain lap weld used on plain straight work, such as round, square, or flat stock, up to a certain weight and length. In nine cases out of every ten, the pieces are prepared and placed together for welding as shown in Fig. 1. The upsetting is done on the extreme ends of the pieces, as shown at *A*, and the greater part of the upset has to be drawn down to form a scarf, the face and sides of which are generally a series of steps or notches as indicated at *B*. The parts are placed in position for welding as shown at *C*. Some blacksmiths claim that notches on a scarf are an advantage and keep the pieces from slipping when being hammered together. This idea is responsible for a great deal of poor welding inasmuch as the notches make the best kind of a trap for slag or any foreign matter that is liable to adhere to them while heating. If this slag is closed in between the pieces, as it is almost sure to be when the points of the scarfs are welded first, as is generally done, all means of escape for slag or dirt is cut off,

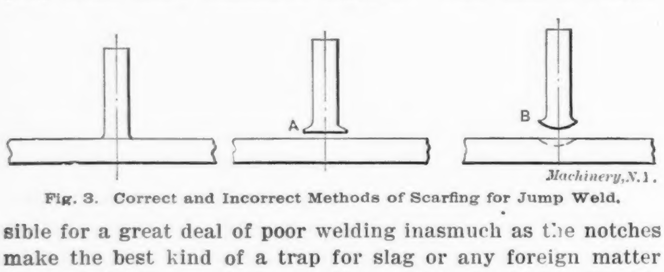

Fig. 3. Correct and Incorrect Methods of Scarfing for Jump Weld.

and the welding will only be effected in spots. The defect will show up in machining if the weld does not come apart before.

If pieces are prepared as shown in Fig. 2, defective welding will be reduced to the minimum. The upsetting should be done at least the thickness of the stock from the end, as at *A*, so that it will not be affected by the scarfing. This makes less upsetting necessary, and the scarfing is more

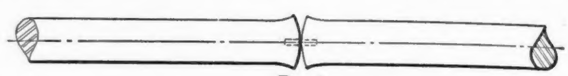

Fig. 4

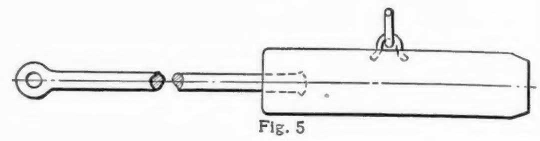

Fig. 5

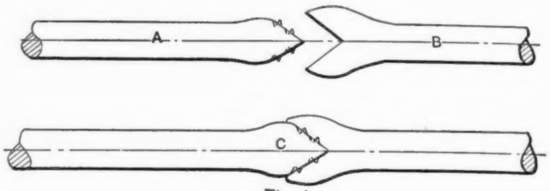

Fig. 6

Fig. 7

Fig. 4. Wrought Iron Shaft prepared for Butt Welding. Fig. 5. Ram for Upsetting Long Bars. Fig. 6. Steel Shaft prepared for Welding. Fig. 7. Carrying Bar for Long, Heavy Forgings.

easily done. The face and sides of the scarf should be fairly smooth, and crowned slightly in the center as at *B*, so that when they have been heated and brought together for welding, the center will be the first part to unite as shown at *C*. Any slag or dirt that may have adhered to the heated surfaces will be forced out as the welding proceeds from the center to the point of one scarf and then to the other.

Jump Weld.

In welding forgings of the style shown in Fig. 3, usually only one piece, the shank, is prepared. It is upset on the extreme end, the edges scarfed and thinned, and the face left

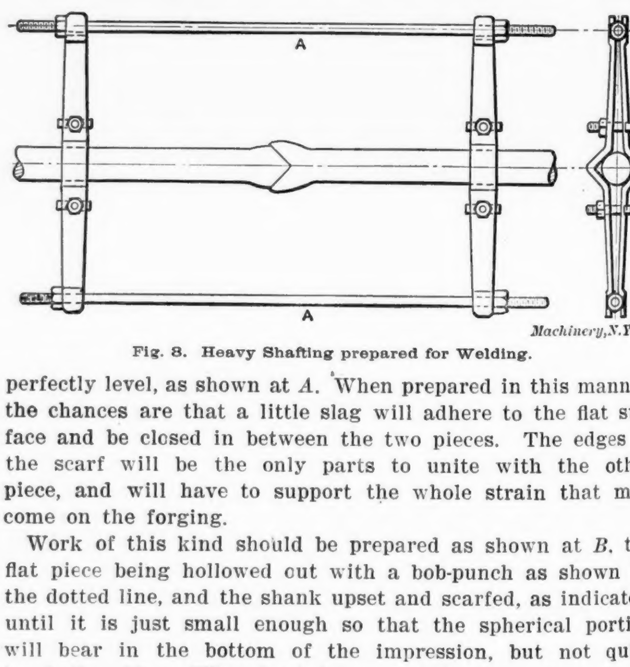

Fig. 8. Heavy Shafting prepared for Welding.

perfectly level, as shown at *A*. When prepared in this manner, the chances are that a little slag will adhere to the flat surface and be closed in between the two pieces. The edges of the scarf will be the only parts to unite with the other piece, and will have to support the whole strain that may come on the forging.

Work of this kind should be prepared as shown at *B*, the flat piece being hollowed out with a bob-punch as shown by the dotted line, and the shank upset and scarfed, as indicated, until it is just small enough so that the spherical portion will bear in the bottom of the impression, but not quite touch the sides. When heated to a welding temperature and placed in position, the first point of adhesion will be at the center, and two or three blows will upset the shank sufficiently to fill the impression. Any slag or dirt will be forced out as the welding proceeds, and a solid piece of work is insured when the weld is completed. This style of welding is known as jump welding.

* For additional information on kindred subjects, see Tools for Increasing Production in Blacksmith Shops in the November issue of MACHINERY, and other articles there referred to.

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Butt Weld.

Shafting and similar work, when made of wrought iron, can be butt-welded to advantage, the only preparation necessary being to upset the ends coming together, slightly crowning them in the center. The two ends are kept in alignment with a dowel pin as shown in Fig. 4. When heated to the proper temperature, the parts may be welded before they are removed from the forge by using a sledge hammer on one end, or, if the pieces are of large dimensions, a ram should be used. The welding commences at the center, and all slag or dirt is forced out as the pieces come together. By the time the weld is complete, the diameter around the heated parts will be found to have increased. This excess can be worked down to the same size as the rest of the piece either at the anvil or steam hammer while it is still at a welding temperature.

Welding Steel.

It is not advisable to butt-weld steel at the forge, as the pieces are liable to come apart when the upset portion is being worked down to the same size as the rest of the piece. All forgings either of ordinary machinery or carbon steel should be made from the solid, if possible. If this is impracticable, welding should be done either by the plain lap method or by split weld. The split weld is seldom used except upon very long or heavy work, such as shafting, lead-screws for long lathes, and similar work where the parts are either too long or too heavy to be heated separately and placed upon each other for welding with any degree of comfort or accuracy. Work of this kind is usually prepared for welding by being heated on the end and upset with a ram of the style shown in Fig. 5, which is suspended from above by a chain attached to the ring of the ram with a hook. The ram is arranged so that it can be adjusted to any height. It is swung horizontally by means of a rope attached to the shank or handle. Three or four men are needed to give it momentum and one man to guide it by the shank. An equal number of men are needed to keep the shaft in position when acted upon by the ram. When the pieces have been sufficiently upset, one is scarfed as shown at *A*, Fig. 6, and the other is split and scarfed in the shape of a snake's head as shown at *B*. A few sharp burrs are raised with a chisel on the sides of *A*. Part *B* is heated and closed in on the burrs which keep it in position, as shown at *G*. The parts are then placed on the forge, heated, and welded in the usual manner at the steam hammer.

Bars of the style shown in Fig. 7 are used to lift the shaft from the forge and convey it to the hammer. One man is required for each end of the bar; sometimes as many as a dozen or more bars are used, according to the length and weight of the work. When the diameter exceeds three inches, the separate pieces are usually held in position by means of clamps, as shown in Fig. 8. When the heat has been raised sufficiently high for welding the pieces, they may be forced together, before removing them from the forge, by using a sledge hammer or a ram on one end of the work. When the pieces have been fairly united, the tie rods *A* are removed, allowing the work to be turned in the fire so that all sides can be brought as near as possible to the same temperature. The shaft is then lifted from the forge to the steam hammer, where the welded portion is worked down to about the same diameter as the remainder, using the clamps which are still left in position for handling and turning it.

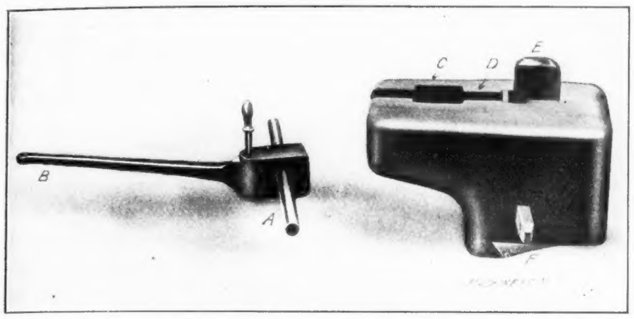


Fig. 9. Upsetting Attachment for Preparing Heavy Shafts for Welding.

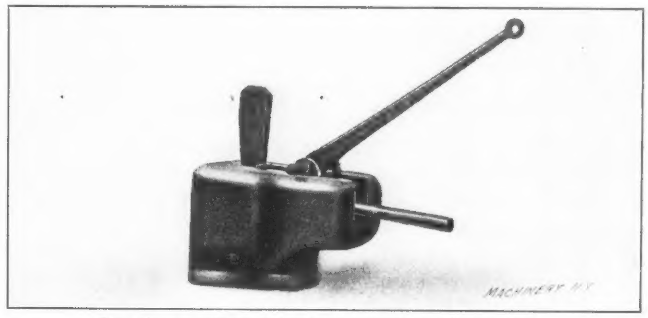


Fig. 10. Upsetting Attachment ready for Operation.

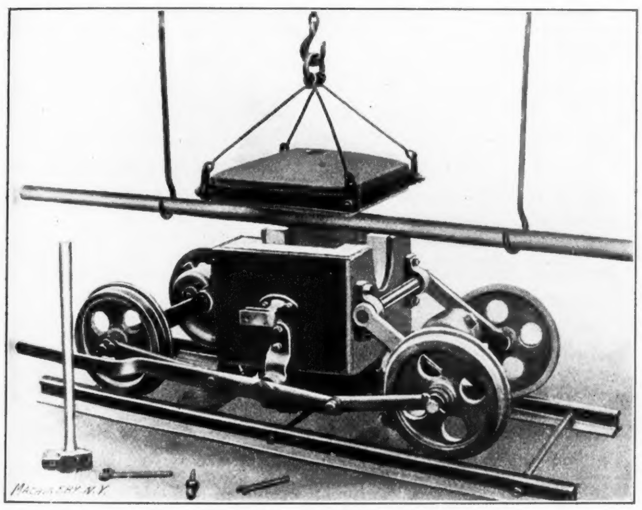


Fig. 11. Portable Forge ready for Use.

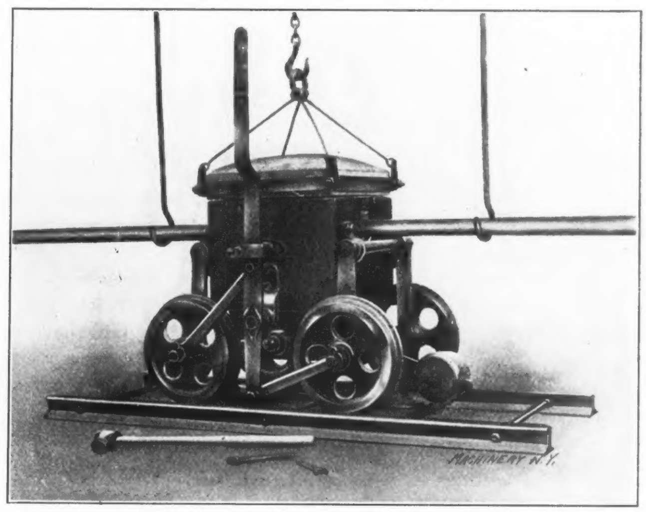


Fig. 12. Portable Forge in Raised Position.

Making Long Lead-screws.

Lead-screws frequently are as long as sixty feet, and occasionally eighty feet or over. Defective welding on this class of work is very serious as it renders the screws practically useless. When work of this nature exceeds the length of the longest lathe in the shop, two or three bars, together equaling in length about the capacity of the available lathe, are welded together, turned, and the thread cut to within about three feet of the end of the bar. This is then returned to the blacksmith shop where a few more lengths are welded on, which are also turned and threaded. This is repeated until the full length has been reached.

To facilitate handling and to reduce the cost of such work, the writer designed the upsetting attachment for the steam hammer, shown in Fig. 9, which takes the place of the ram and can be used with considerably less help, the blacksmith, his helper, and the steam hammer operator being all that is required. To use the attachment, the anvil block is removed from the steam hammer, and the fixture is keyed in its place. The ends of the bars to be upset are heated, placed in V-blocks *A*, which are notched or toothed inside to insure their bearing being firm upon the work, the grip being just

behind the heated portion. The V-blocks are brought to bear upon the work by means of a lever and cam *B*. The V-blocks with the work held firmly between them are placed in a recess *C* in the end of the fixture, thereby preventing them from moving backwards. A steel plate made to slide in groove *D* comes in contact with the hot end of the work. The plate is forced forward in the groove by wedge *E*, driven home by the steam hammer. Should the wedge in any way become cramped, it can be removed by a small wedge *F* which

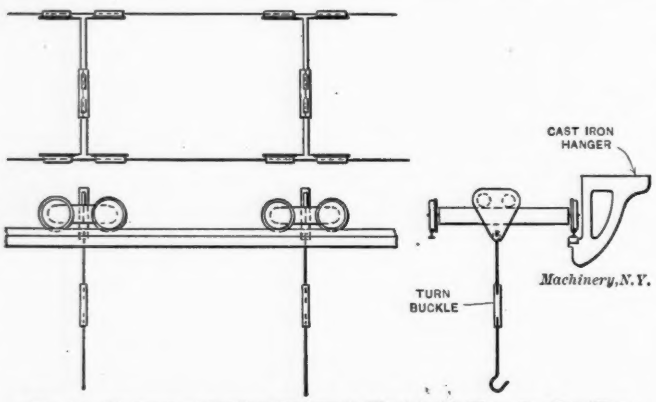


Fig. 13. Diagram of Trolley System in Blacksmith Shop for Handling Long Lead-screws.

crosses its point near the lower side of the attachment. If the amount of upsetting done at one operation is insufficient, the grip can be released upon the work in the V-blocks, the shaft pushed through as far as it will go, and the operation repeated. A fixture of this style can be arranged to form collars or in fact any kind of work where upsetting is necessary. In Fig. 10, the device is shown ready for operation.

Portable Forge for Welding.

Figs. 11 and 12 show a portable forge specially designed by the writer for heating long work to be welded. The general arrangements are such as to afford greater convenience in heating and handling this class of work than is possible with an ordinary forge. By its use a saving of at least 75 per cent in help is effected. In Fig. 11 the work is shown in position ready for heating and supported by hooks. The body of the forge is made deep enough to support the sides of the fire which necessarily have to be high enough to allow the work to be covered by it. The forge is lined with fire brick to prevent the sides getting overheated and warped. The top is covered with a large fire brick bound around the edges with iron straps, and supported by a chain from above. A hole in the center of the brick allows smoke and gases to escape; this hole can be closed or partly closed, when necessary, with a piece of sheet iron or boiler plate. The fire brick cover gives all the advantages and none of the disadvantages of a hollow fire for welding, as it can be placed in position or removed without in the least disturbing the fire. The forge is mounted on wheels attached to the body with axles which can be spread by means of a lever and link motion (see Figs. 11 and 12), allowing the body to drop far enough for work to be removed without lifting it to clear the sides of the fire. To make the forge easily raised and lowered, the body is counterweighted, the weights being made to slide on levers so that they can be adjusted to give a perfect balance. They are held in position with set-screws. The other ends of the levers are connected to the body with links, and work in fulcrums attached to the track on which the wheels rest. The fulcrums are just high enough to clear the bottom of the air chamber when the forge is raised to its full height, which allows it to be easily removed from the track when the levers are disconnected. Fig. 11 shows the forge lowered, and the brick cover suspended by the chain clear of the work. The latter can be conveyed to the steam hammer, as it rests in hooks connected with an overhead trolley. Fig. 12 shows a view of the forge when raised to its highest position by linkage.

Air is supplied from a blower through a flexible hose attached to a flanged pipe. The shut-off can be opened or closed from either side of the forge by means of the two small levers. When in use, the forge has to be placed so that when the work to be welded is in position for heating it will be on a level with the lower die of the steam hammer. It is necessary to use a trolley system of the style indicated in Fig. 13 to convey the work from the forge to the steam hammer and from the steam hammer to the forge. The side track should be long enough to allow handling the longest work and wide enough to reach from the forge to the steam hammer. The cross trolleys, of which there should be at least four, support the work in hooks fitted with turnbuckles so that they can be adjusted to the proper length. With four or more cross trolleys the longest work can be perfectly balanced and conveyed from forge to steam hammer without any danger of bending or distorting the hot portion. This type of forge can be used for purposes other than welding. By closing the opening on one side, it could be used as a furnace for heating any kind of forging within its capacity. Being portable, it can be placed near a steam or trip hammer or any other place where it would be most convenient for the work being done.

Fig. 14 shows the style of tuyere used in the forge already described. This type of tuyere can be used with any kind of a forge and will give better results and less trouble than the average tuyere in general use, especially in welding. It being in the shape of half a sphere, clinkers and slag will not choke it but will form a ring around the base and as a rule can be removed from the fire without breaking them up. Most of tuyeres in general use are usually flat or slightly hollow. Slag or clinkers accumulate in the center, and are a source of annoyance in doing any kind of forge work, especially welding. The tuyere here shown has a single hole to admit air which tends to concentrate the heat and keep the fire from spreading. No bolts or screws are needed to keep it in position; a little fireclay packed between it and the bottom of the forge is all that is necessary to make it air-tight at the base and keep it in place.

In all kinds of welding it is important that there be a fair depth of fire between the tuyere and the work so that the oxygen in the air will be consumed before it reaches the pieces being heated; otherwise the work will scale and only unite with difficulty if it unites at all.

For any kind of welding, hollow fires should be used when the shape of the work will permit. In no case should the work be allowed to come in contact with the fuel any more than is necessary.

Fluxes for Welding.

Wrought iron can be welded in a clean, well-kept fire without necessarily using a flux of any kind except when the work is very thin. Fine, clean sand will answer the purpose. With steel of any kind it is different, as there is no kind of steel that will stand the same amount of heat as wrought iron will. A flux of some kind must be used to get the separate pieces in a condition to adhere to each other. There is a large variety of welding compounds on the market; some of them are suited for one class of welding, some of them for other classes. Welding plates or any of the gritty brands are suitable for any kind of welding when the pieces are heated separately. For pieces put together previous to welding, as in split welds, or when taking a second heat, usually termed a "wash," a compound or flux that will flow freely should be used.

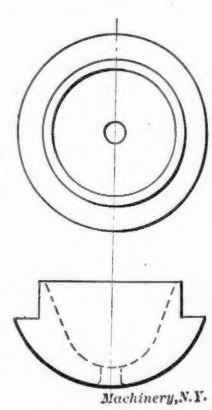


Fig. 14. Tuyere for Portable Forge in Figs. 11 and 12.

When borax is used for a flux it will give the best results if burned, which can be done by heating it in a crucible until it has been reduced to a liquid state. It should then be poured on a flat surface to form a sheet. When cold it can easily be broken up and pulverized. This can be used as it is, or it can be mixed with an equal quantity of fine, clean sand and about 25 per cent of iron (not steel) filings or small chips.

Too much care or attention cannot be given to welding. Poor welding may mean a railway wreck, a steamship disaster, or a number of other things likely to endanger life and property.

A GERMAN DESIGN OF FRICTION SPINDLE PRESS.

So-called friction spindle presses are used to a very large extent on the European continent, and especially in Germany, for forging and stamping purposes. A type of this class of press in an improved form, brought out by the firm of Brüder Boye, Berlin, Germany, is illustrated in Fig. 1. American readers will at once recognize that presses of this type are seldom, if ever, seen in this country.

There is one pulley with a friction wheel on each side of the press, mounted on horizontal shafts in such a manner that either of the friction wheels may be shifted to engage the rim of the heavy central friction driving wheel, attached

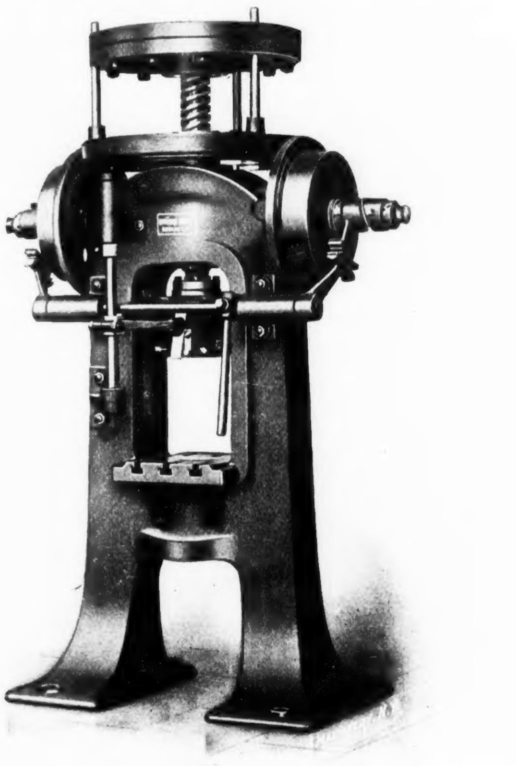


Fig. 1. Friction-driven Press built by Brüder Boye, Berlin, Germany.

to a vertical screw. By means of this screw the ram of the press is raised or lowered. The advantages claimed for this type of machine are that it provides for an "elastic" blow, the drive not being positive, and that therefore this design does not require as large dimensions of standards, bearings, shafts, etc., as are required in presses with positive drive, in order to prevent breakage. Besides their use for drop forg-

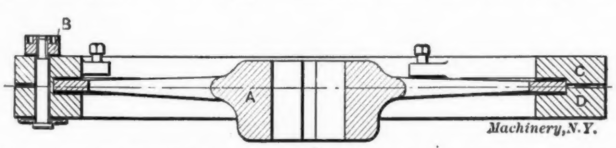


Fig. 2. Safety Fly-wheel used on Brüder Boye's Friction-driven Presses.

ing, bolt-heading, etc., these presses are also used instead of hydraulic presses and steam hammers for general forging work. For these purposes they possess the advantage of smaller operating cost and cheaper foundations.

The type of press shown in Fig. 1 has been improved in several details over previous designs, the main features of improvement being a special safety fly-wheel, a new driving device and a special arrangement for the friction brake. The design of the fly-wheel, which is placed at the top of the machine at the upper end of the screw, is shown in Fig. 2, and known as Schull's system. In former constructions, it has been common to make the fly-wheels in a solid piece, rim, spokes and hub all cast together. The fly-wheel shown here is made in an entirely different way. It consists of a disk *A*, which forms the hub and the spokes of the fly-wheel, and of two fly-wheel rings *C* and *D*. Between the disk and the rings *C* and *D* are arranged segments or fiber disks. The fly-wheel rings *C* and *D* are tightened to the disk *A* by means of a number of nuts *B*, screwing onto bolts passing through the two rings. These nuts can be tightened only by means of a special spanner wrench having a form as shown in Fig. 3, for the smaller presses, and a form shown in Fig. 4 for the larger presses, the feature of this wrench being that it is provided with a friction attachment, making it impos-

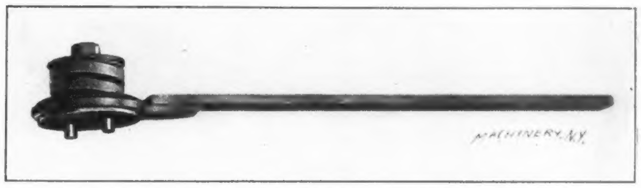


Fig. 3. Friction Wrench for Tightening Nuts in Fly-wheel.

sible to tighten the nuts more than a certain amount, and thus providing for a chance of slip between disk *A* and rings *C* and *D*, if the resistance becomes great enough to overcome the friction between these parts. On account of the peculiar construction of the fly-wheel, this possibility of slip between the fly-wheel rim and the hub, which prevents the fly-wheel from giving out stored-up energy above a certain amount, eliminates breakage of the parts of the press. The capacity of the friction spindle press can also be increased largely on account of this fly-wheel construction, and it is interesting to note to what an extent this construction of fly-wheel permits the full capacity of the press to be taken advantage of. In Fig. 5 are shown four cylinders of tool steel. The first and third views show pieces compressed on an ordinary press of this type, the machine being used to the limit permissible, without risking breakage; whereas, the cylinders in the second and fourth views are compressed on the same press when equipped with the safety fly-wheel.

Fig. 4. Friction Wrench with Worm and Worm-wheel Drive, used for Large Sizes of Presses.

The driving device shown in Fig. 6 has also several points of interest. This differs considerably from that found in the old type presses. The fly-wheel on the older type serves at the same time as friction driving wheel, and as accumulator of energy. For this reason it was necessary to use large friction disks for turning the fly-wheel, and furthermore the whole driving device of the presses had to be arranged largely above the press. The mounting of the driving disks and the renewal of the leather covering was therefore rather difficult, so that this work was only done in cases where it became impossible to work further with the press. In the machine shown, however, the fly-wheel is used only as an accumulator of energy and the friction driving wheel *E* is sepa-

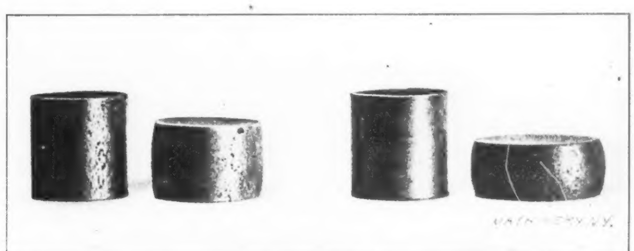


Fig. 5. Comparison of Capacity of Presses having Ordinary and Safety Fly-wheels.

rated from it, as shown in Fig. 6. The driving wheel is connected with the fly-wheel by means of pins *F* which pass with a free fit through holes in the fly-wheel. When the driving wheel *E* is rotated, the fly-wheel and the spindle which is connected with it are turned, and the ram is lifted or lowered as the case may be, and while the old presses are provided with

large driving disks placed on movable shafts, it is possible in this design to arrange for smaller driving pulleys and fixed shafts on both sides of the press, as shown in Fig. 6. The control of the machine can be made simpler and more positive than in the old press. As indicated, the movement of the controller handle P is transmitted to a shaft provided

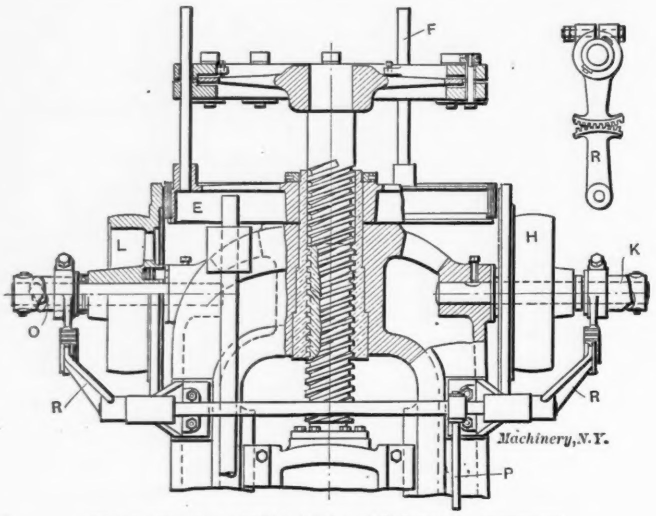


Fig. 6. Section of Fly-wheel and Driving Arrangement.

with two arms R, having gear segments at their ends. (See detail view in upper right-hand corner, Fig. 6.) These segments mesh with other segments on arms attached to cams K and O, which in turn work against cam surfaces on the ends of bushings placed on the ends of the pulley shafts. By means of small springs the pulleys L and H are always held out of contact with the driving wheel E, but when the handle

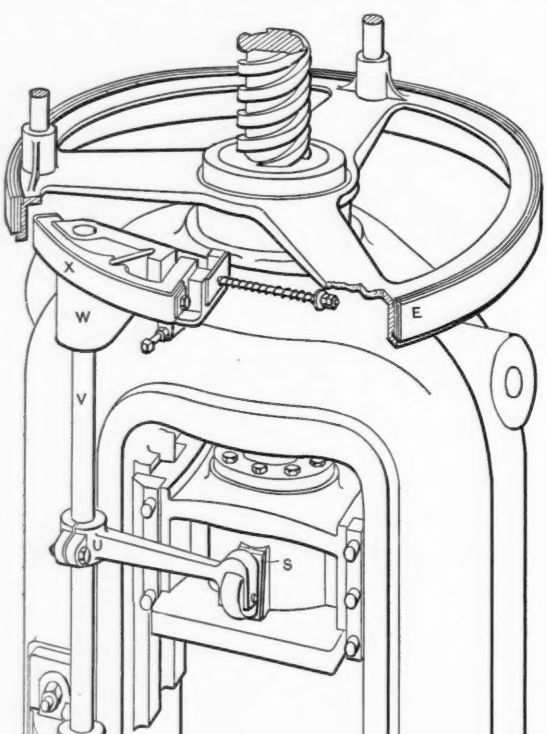


Fig. 7. Design and Action of Brake.

P is gripped by the operator and its shaft turned so that the segments K and O, with their cams, are brought against the cam surfaces on the bushings on the end of the pulley shafts, either one of the pulleys H and L are easily moved against the driving wheel E. When the controller handle is permitted to return to its original position, the pulleys H and L immediately move away from the driving gear. This driving device gives an easy and absolutely safe control of the machine. The cam bushings on the ends of the pulley shafts are held in place by set-screws, so that it is very easy to turn them at any time to any required angle, and to set them at the correct distance from the cam surface on the segment in order to obtain a good and precise working of the whole driving device.

Another interesting feature of these presses is the arrangement of the brake for the movement of the driving pulley, as shown in Fig. 7. The oblique surface S on the ram of the press controls, through a roller, a lever U on the shaft V, which in turn carries the brake W. The part X of this brake is covered with leather, and acts upon the inner rim of the driving wheel E. The lever U can be set at any required place on the shaft V by means of the clamping arrangement shown. By this arrangement the ram can be stopped at a predetermined point, according to the setting of the lever U. The working of the brake is so precise that it is possible to control the movement of the ram within 1/16 inch, and it is therefore possible to use the smallest strokes with precision. The advantage of the brake is not only the precise control of of the ram, but also the added security to the operator.

* * *

TEMPER COLORS, AND TEMPERATURES AND COLORS FOR HARDENING.

The following tables of temper colors, and temperatures and colors for hardening are published in a booklet issued by the Halcomb Steel Co., Syracuse, N. Y., and Chicago, Ill. The temperatures tabulated are a result of personal investigations made by Mr. Garson Myers, manager Chicago branch; a gas furnace equipped with a pyrometer was used. After the records were made they were tested by two experienced tool steel hardeners, one using an electric heating furnace with a pyrometer and the other a magnetic heating furnace also connected with a pyrometer. Neither knew of the other's work, but there was an astonishing uniformity in the results of their independent investigations, corresponding very closely to the figures obtained by Mr. Myers. The company feels that it can without reserve or hesitation recommend that the temperatures and colors are absolutely reliable, having been twice verified by independent workers.

HEAT TEMPERATURES AND COLORS FOR HARDENING.

Degrees C.	Degrees F.	Colors.
400	752	Red heat, visible in the dark.
474	885	Red heat, visible in the twilight.
525	975	Red heat, visible in the daylight.
581	1077	Red heat, visible in the sunlight.
700	1292	Dark red.
800	1472	Dull cherry red.
900	1652	Cherry red.
1000	1832	Bright cherry red.
1100	2012	Orange red.
1200	2192	Orange yellow.
1300	2372	Yellow white.
1400	2552	White welding heat.
1500	2732	Brilliant white.
1600	2912	Dazzling white (bluish white).

The heat and temper colors to which tools should be drawn were contributed by a hardener and temperer of long experience, working on all grades of tool steels, and they also are considered to be perfectly reliable.

HEATS AND TEMPER COLORS OF STEEL.

Degrees C.	Degrees F.	Colors.
215.6	420	Very faint yellow.
221.1	430	Very pale yellow.
226.7	440	Light yellow.
232.2	450	Pale straw yellow.
237.8	460	Straw yellow.
243.3	470	Deep straw yellow.
248.9	480	Dark yellow.
254.4	490	Yellow brown.
260.0	500	Brown yellow.
265.6	510	Spotted red brown.
271.1	520	Brown purple.
276.7	530	Light purple.
282.2	540	Full purple.
287.8	550	Dark purple.
293.3	560	Full blue.
298.9	570	Dark blue.
315.6	600	Very dark blue.

ITEMS OF MECHANICAL INTEREST.

MANGANESE STEEL RAILS.

Within a few months after the elevated division of the Boston Elevated Railway Co. was open for traffic in June, 1901, it was found that the rails on the curves would wear out at a very rapid rate, and the question of maintenance and the cost of rail renewals became a very serious problem. It has been found, however, that manganese steel rails are far superior to ordinary bessemer rails, even when the difference in price is considered, and the accompanying illustrations, Figs. 1 and 2, will give a comparison of the tremendous difference between the wearing qualities of the two

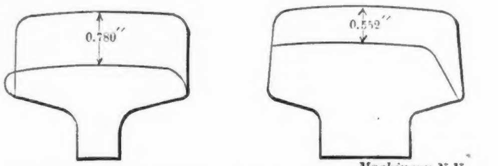


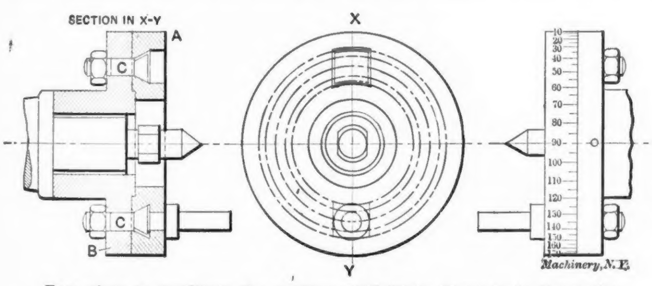
Fig. 1. Ordinary Bessemer Rail after 44 Days' Service on Curve near Park St. Station, Boston Elevated Railway.

Fig. 2. Manganese Steel Rail after 6 Years' 3 Months' and 7 Days' Service. Rail still in use.

classes of rails. In Fig. 1 is shown an ordinary bessemer rail used for 44 days, the lower profile line showing the extent of the wear in this time, while in Fig. 2 is shown a manganese steel rail, which has been in use for 6 years, 3 months and 7 days, and is still in service. No better evidence than this could be shown of the superiority of the manganese steel rail.

FACE-PLATE CONSTRUCTION FOR THREADING LATHES.

The accompanying illustration, taken from the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, issue of August 25, 1908, shows an interesting development of face-plate arrangement for threading lathes, brought out by the firm of Ferdinand Pless, Fechenheim, a. M., Germany. The face-plate is intended for facilitating the cutting of multiple threads in the lathe. As seen from the illustration, it consists of two parts, *A* and *B*, the part *A* being free to be rotated in relation to the part *B* when the bolts *C* are loosened. The driving pin for the lathe dog is attached to the plate *A*, and in cutting multiple threads, when one thread is finished, the bolts *C* are simply loosened, and the plate *A* turned around in relation to the spindle of the machine an amount corresponding



Face-plate to facilitate the cutting of Multiple Threads in the Lathe.

to the type of thread being cut; thus, for instance, if a double thread is cut, the plate *A* is turned around one-half revolution, or 180 degrees; for triple thread, 120 degrees; for a quadruple thread, 90 degrees, etc. The periphery of plate *A* is graduated in degrees, and a zero line provided on plate *B*, so that the required setting is very easily obtained. On lathes which are constantly used for thread cutting the advantage of an arrangement of this type is very evident, as it saves employing any of the more or less cumbersome methods in vogue for moving the work in relation to the tool when cutting multiple threads.

NEW TYPE OF MILLING CUTTER.

An interesting milling cutter especially intended and made for fluting locomotive main and side rods, and for milling large keyways in axles, has been devised by Mr. T. R. Hellgren, of the Aurora shops of the Chicago, Burlington & Quincy Railroad. A general view of the cutter is shown in the half-tone Fig. 1; and the line engraving Fig. 2, shows the dimensions for a 9-inch diameter cutter with 2½-inch face. It will be seen that the characteristic feature of the cutter is that every alternate full tooth is cut on a right-hand and left-hand spiral, respectively, and one-half tooth is cut in between every two full teeth, this tooth being on the same spiral as

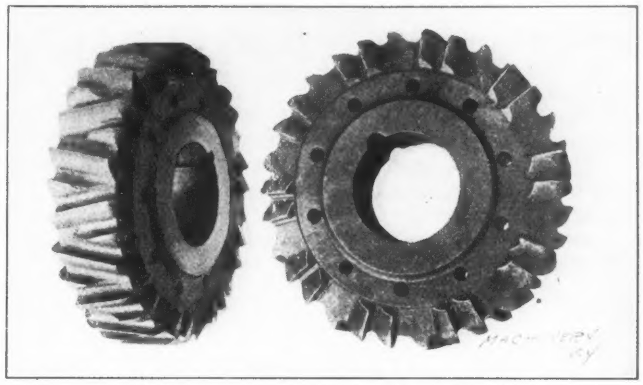


Fig. 1. General Appearance of Hellgren's New Type of Milling Cutter.

the full tooth in front of it. While this cutter will be rather expensive to manufacture, it is evident that it possesses a cutting action far superior to that of cutters having the teeth either straight across the face of the cutter, or all inclined to the same spiral angle. The inventor has applied for a patent on his idea, for which he claims that the greatest

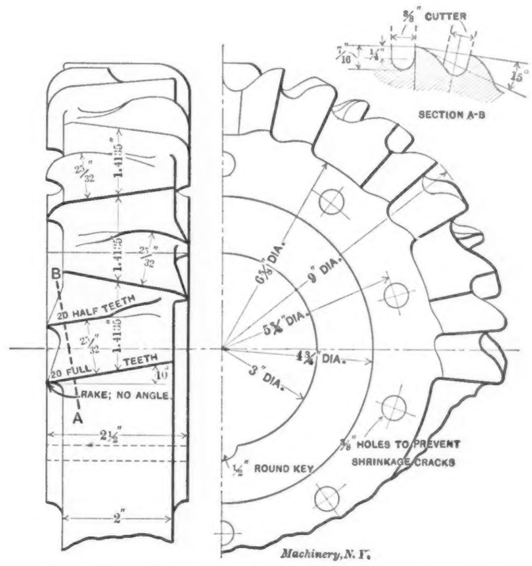


Fig. 2. Detail Drawing of New Type of Milling Cutter.

advantage is that in the first place the work is not struck by any two points on the same tooth at the same time, thereby overcoming the objection to cutters with straight teeth, and secondly that no severe side strains are produced on the arbor as is the case with cutters having spiral teeth in one direction only.

* * *

An ingenious and interesting use of the telautograph—an instrument for reproducing writing at a distance, invented by Prof. Elisha Gray—was made by a number of New York daily newspapers to bulletin election returns. In this instrument the operator's pencil is connected to levers and the motion of writing is reproduced by similar levers at the receiving station, the receiving pencil making an exact copy of the writing, sketches, etc., made at the transmitting station. The reproducing instruments in the bulletin machines were placed in the focus of the lantern so that the writing was thrown onto screens, magnified many times and legible several hundred feet away. The scheme was eminently satisfactory, there being no loss of time between the receipt of the news and the preparation of copy, as is the case with the ordinary projector using the usual style of copy. Moreover, there was the interest of following the movements of the pencil on the screen, noting its hesitation when spelling such words as "Onondaga," and the other human characteristics with which it was uncannily endowed.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1908.

PAID CIRCULATION FOR NOVEMBER, 1908, 21,086 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

TOOL-MAKING AND MANUFACTURING.

It is a matter of common knowledge with our readers that interchangeable manufacturing is *cheap* manufacturing, when compared with the old-time method of making the parts of machines without the use of jigs, fixtures and gages. That the identical parts of modern products, such as rifles, revolvers, watches, typewriters, and hundreds of other articles of common use are interchangeable, is really an incidental feature of the jig and fixture system—a very valuable feature, it is true; but not the fundamental reason for its general use, as some well-informed mechanics seem to think. Two machines, or a dozen, could be made from the same drawings without any of the identical parts being exactly the same, or anywhere near it, as a tool-maker would regard the measurements; and all these machines would give perfect satisfaction. If only a limited number of a given type of machine or tool is to be produced, it is a serious problem to discover whether it would be best to build jigs and fixtures for so-called interchangeable manufacture, but really cheap manufacture, or to avoid the heavy tool-making expense and build the product "every one like itself." The manufacturing cost by the latter method would be greater than by the use of jigs, fixtures, press tools, and other features of modern manufacturing, but the over-head expense of that equipment might swamp the enterprise should the output be comparatively small.

A valuable tool was patented a few months ago by a toolmaker, which may be used widely, but is not likely to be sold in large numbers. By this we mean that it is not a tool that every mechanic would want, but one that almost every up-to-date shop would supply in its tool-room when its merits became known. The inventor and his promoters are at a standstill as regards manufacturing, because of the lack of the comparatively large capital required for the elaborate equipment which they believe should be provided. Being toolmakers, they are unable to entertain the idea of producing the tool by any other than the fámiliar, exact system.

If every manufacturing business in successful operation today had been obliged to start with a first-class equipment, doubtless many of them never would have reached their present state of development. It is quite feasible to turn out many products by a system that is not strictly interchangeable, but which answers practical purposes very well, save that the manufacturing cost cannot be made as low as by the interchangeable system when the tool equipment has once been provided. In the tool above referred to, the matter of interchangeability of the parts and of exact accuracy is not important, save in one detail; and this can be readily provided for by well-known processes familiar to mechanics.

The training of a tool-maker tends to make him ignore the common methods of manufacture, wherein extreme precision and interchangeability are virtually sacrificed to practical conditions that must be met if the business is to be started without heavy initial outlay. After a business has been successfully launched, the refinements of modern manufacture can be developed with profit; but it is better to start without them than not to start at all.

* * *

METHODS OF REWARDING LABOR.

At the annual convention of the National Machine Tool Builders' Association in New York, a paper was presented by Mr. Harrington Emerson on various methods of paying employes, with a statement of the advantages and disadvantages of each to the employer and the employe. Mr. Emerson has developed a system under which labor is individualized, each man being rated according to his personal efficiency. A standard day's work is established by rigid investigation, and the employe's personal efficiency is determined accordingly. The skilled and rapid worker does more, and is paid more, than his less skillful and slower shopmates.

The discussion following the paper was animated, the general sentiment seeming to be that no one could determine a standard for a day's labor, and that the determination of a standard was the crux of the problem. Conditions and practices are constantly changing and improving, and a full day's work now may be a small product a year from now. The tremendous influence of the discovery of high-speed steel was quoted to show what changes in machine work are made by inventions and discoveries, and it was mentioned that some kinds of lathe turning now require only from one-half to one-quarter the time required with ordinary carbon steel tools.

Students of economics realize the practical need for an equitable wage system, but they cannot help deprecating attempts to reward labor according to its production. In the last analysis it seems to us that the schemes devised for stimulating labor production are merely thinly disguised plans for getting more out of the men for a *living wage*. Labor may profit temporarily by the introduction of premium, bonus or piece-work plans, but eventually all wages are determined by the law of supply and demand, and will be at best a living wage only, under our present economic system. The man who works with his hands and brain, without ownership in the enterprise, must expect that the larger profit on his product will be absorbed by others, who, through their ownership of land and public or private utilities, occupy strategic positions. The workman is benefited by increased production, but not directly, except temporarily.

The competitive system pits one man against another, and increases production; but it also pits one concern against another, and tends to reduce the selling prices of the product. It is doubtful, in the end, if either the employe or the employer profits materially by greatly increased production per capita, except as the general standard of living is raised. The net result of the last century of progress, during which machine tools, railroads, steamships, telegraphs, telephones and hundreds of other great wealth producers have originated, is that mankind eats better, sleeps better, lives better than before; but the great majority is not released from the necessity of constant labor. Working people simply get more for what they do—and require more.

We hope that the appeal to selfishness made by all the present plans for rewarding labor, will some day give way to methods addressed to the nobler characteristics of mankind—pride in production and quality, sense of civic duty, a keener understanding of one's duty to his fellowmen and of the need for cooperation, and the application of the golden rule in all its bearings. But before this millennium will arrive, both employer and employe must handle the question from a totally different standpoint from what they do at present.

FORFEITURE OF PATENT RIGHTS.

E. C. SMITH.*

The writer has read with interest the editorial in the November issue regarding patented inventions which are wilfully kept dormant or suffered to remain so, but the sentiment regarding forfeiture is not concurred with. In the first place, an invention is not one of the "bounties of nature," nor can it be properly considered or treated as such. In that category are the natural elements and their various combinations in the mineral formations, animal and vegetable life, and in physical formations of the earth. They are the sensible and tangible products of nature's creative action, and we believe them provided for and essential to the welfare and conservation of the race. In this aspect it is inexpedient that they should be subject, either in part or as a whole, to exclusive privilege for a few, or their use and enjoyment limited by a few.

Inventions are thought creations and their corporeal embodiments are the visible and tangible products of creative mental acts. They are mental progeny just as children are physical progeny, and are therefore akin to the individual. The inventor's right to his invention is therefore deemed inherent and inviolable.

That patents were originally devised to accord the patentee exclusive use of the patented art or article, for the purpose of assuring him a reasonable reward for his enterprise is unquestionably true, but it must be remembered that the first patents were granted largely, if not almost exclusively, for importation of industries rather than for the discovery or creation of new arts or devices. With the development and growth of individual inventive resource there has also developed the sentiment that the products of such individual effort essentially belong to the individual. Inasmuch as invention is incorporeal property and unsusceptible of precise definition like real and personal property, special means were devised for its protection and the protection of the inventor's rights. To conserve these rights the patent system has been established. Under this system the public enters into a contract with the inventor whereby his rights may be defended. To secure his means of defense—the letters-patent—the inventor must disclose his invention completely. This disclosure, as I understand it, is not so much for the purpose of enabling others to practice that particular invention as to enlighten them as to the mode of practice, opening up new fields of endeavor and directing inventive thought in new lines.

It must be admitted that a patented invention even though kept dormant for seventeen years, is more valuable to the public than if unpatented and undisclosed. If the result secured by the invention is peculiarly desirable then the desire to secure the same or similar results by other means will whet the inventive wit the keener.

Laying aside academic considerations, there are practical and cogent reasons for not causing forfeiture of patents on account of non-practice of inventions. It sometimes happens that the invention disclosed in a patent containing broad, basic and therefore valuable claims, is in a form less desirable for use and less economical of production than that of a subordinate patent. It is not unusual for the proprietor of one patent, the invention of which is practiced, to have several other patents covering less desirable forms of construction which are not practiced.

Many inventors diligently pursue the commercial exploitation of their inventions without success for the greater part of the life of their patents. Surely it were unfair to deprive the generic inventor of his basic claims unless he manufactures continuously for seventeen years a device that is undesirable and expensive, simply because it is the patented embodiment of those broad claims. Equally unjust would it be to compel a proprietor of several patents to manufacture several alternative forms of apparatus for seventeen years, with all the attendant cost for plant, material and labor, simply to maintain those patents. Superlatively unjust were it to deprive a man of his patent rights because of failure to practice his inventions, when that failure is due to adverse circumstances.

Any question as to "best use" would start a train of technicalities in an action for forfeiture or in defending against an action for infringement more involved than any of our present day patent litigation is cumbered with, and the merits of a case would turn on matters of opinion rather than fact. The only way in which the justice or injustice of such forfeiture or defence against infringement could be ascertained would be by a hearing before some tribunal which would only slightly mitigate and not entirely correct abuse. How many grasping corporations and enviously malign individuals would harry poor inventors with actions for forfeiture? How much incentive would one have to invent were there hung above his head the Damoclean sword of forfeiture proceedings?

The path of the inventor is sufficiently precarious as it is, without adding further obstructions and detriments, and seventeen years is a short period to wait, even for the inventor who derives satisfaction from withholding his patented device from public use. The rights of the public are better cared for with respect to patents than ever before. To secure a patent an inventor must exercise diligence in applying for a patent and in prosecuting his application. But when his patent has been obtained, the inventor is secure in his exclusive rights, of which he can be divested only by due process and because of defective title, which must be conclusively proved.

The world owes much to the inventor, and if some wanton vagary leads him to exercise his prerogative under letters-patent, to the extent of refusing the public the use of some one invention, it, in turn, should remember the multitude of inventions, the use of which it has had, and not overlook the sundry inventions it has wantonly filched or ruthlessly wrested from the inventor.

[The arguments presented by our correspondent in favor of the rights of inventors to protection in non-worked patent rights, are undoubtedly correct from a legal point of view, and that we concur with this opinion was plainly stated in the editorial referred to. From an ethical point of view, however, it appears that the inventor who prevents others from using an invention which he will not or cannot use himself, resembles very much the dog in the manger. In the case of an invention it is not merely a question of it being a creation of a certain individual, and that he, therefore, has an absolute and exclusive right to the profit afforded by the patent, because, during the seventeen years a patent is in force, a number of other inventors may independently work out and invent practically the same appliance or method as has formerly been invented; and while in the case of patents obtained and *used*, the first inventor naturally must be protected on account of priority, it is difficult to see his moral right to prevent others from using independently worked out ideas which he does *not* care to *use* himself. Besides, the question hardly involves inventors as individuals, because it is hard to conceive of an inventor who would acquire a patent and refuse to work it if it had any commercial value. It is much more a question of the ethics of the not unusual practice of corporations of buying up patents from individual inventors and keeping the patent dormant because it may interfere with some inferior product of theirs which they prefer to continue to place on the market. We do not think that the requirement of working a patent within a certain number of years after being granted would involve a hardship for inventors as individuals. On the contrary, it is likely that such a clause would prove beneficial to the real inventor's interests. That the idea is not new and that the principle stated is recognized as correct is evidenced by the fact that the patent laws of most European countries contain a clause requiring the patent to be worked within a certain number of years after being granted. If the inventor or others to whom he may assign the rights to his patent do not care or do not find it profitable to make any use of the patent, it is either impractical, and in such a case there could be little reasonable objection to infringement; or it is held out of use for commercial reasons which are not commendable, and thus actually work an injury to the very inventor who is supposed to be protected. It must be understood that the question raised in the editorial referred to was one not of whether the present law was correctly interpreted, but of whether the law corresponded to true moral principle.—EDITOR.]

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ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

At the convention of the American Street and Interurban Engineering Association, at Atlantic City, last October, it was proposed that street car wheels should be made without flanges, and the flanges instead placed on the rails. Many plausible arguments were brought forward to show the superiority of such a system over the present one.

According to *Page's Weekly*, the company formed last summer at Hamburg for utilizing the forces of the tides near the mouth of the Elbe, to which reference was made in the June issue of MACHINERY, has raised a capital of $750,000, and various buildings connected with the undertaking are now in course of completion at Cuxhaven. It is intended to use the tides for the production of electric power for factories.

It is stated by the *Scientific American* that a company has been formed for boring another tunnel connecting Switzerland and Italy under the Alps. This tunnel will begin at Martingly in Switzerland, and come out at Courmayeur, Italy. It is planned to be 28 miles long, and is expected, it is said, to be completed in three years. So far, however, it exists only on paper, and like many of the engineering projects in the way of tunneling of late years, may remain in that state.

Among the concerns mentioned in our November issue as having joined the National Machine Tool Builders' Association was that of the Powell Tool Co., Worcester, Mass. As published it appeared as the Powell Planer Co., and as such was erroneous. The Powell Planer Co. was originally the name of the Woodward & Powell Planer Co. and the name is held to be the property of the said company. The Woodward & Powell Planer Co. has been a member of the National Machine Tool Builders' Association for the past six years.

It is stated in the monthly *Consular and Trade Reports* for September, issued by the Department of Commerce and Labor, that in extensive competitive tests carried out in France, a decrease in consumption of gasoline, amounting to 53 per cent per ton-mile, as compared with the results of similar tests performed in 1907, has been achieved. Sixty per cent of all the cars which entered the race made the entire tour, which occupied twenty-seven days, during which 2,175 miles were covered. The total average consumption of gasoline per ton-mile was 0.074 quart as compared with 0.157 quart in similar tests undertaken in 1907.

Remarkable steam economy was shown by a stationary, self-contained engine and boiler set of the portable engine type, built by the firm of R. Wolf, of Magdeburg, Germany, and recently tested by Professor M. Gutermuth, of Darmstadt. The tests are reported in the *Zeitschrift des Vereines deutscher Ingenieure* of October 3, 1908. When the engine tested developed 103 H.P., it showed a steam consumption of only 8.86 pounds per horse-power-hour, and a coal consumption (using coal of 13,900 B.T.U. per pound) of 1.06 pound per horse-power-hour. This engine works on superheated steam, and is compounded, having both cylinders seated in the smoke box, and therefore jacketed by the hot flue gases. The superheat at the entry into the high-pressure cylinder averaged 236 degrees F., and after having passed through a reheater, the steam entered into the low-pressure cylinder with a superheat of 200 degrees F. The mechanical efficiency of the engine alone varied from 93 to 95 per cent.

Consul Thomas H. Norton, of Chemnitz, Germany, states that electric steel melting furnaces are becoming more and more used at German iron works and that one important steel works, engaged in the production of tool steel products, intends to replace its whole battery of crucible furnaces by one large electric melting furnace, the cause for the change being the reduction of cost possible. The whole equipment consisted of thirty-two furnaces, each containing six crucibles, with a capacity of 77 pounds. These are to be replaced by an electric furnace capable of holding a charge of 2,200 pounds. The advantages of the electric process are stated briefly as follows: cheaper raw material can be employed in place of the more expensive Swedish iron formerly required; in melting quantities of one ton at a time, it is possible to produce more homogeneous masses of a well-defined grade; and, finally, the molten steel leaves the furnace at a much higher temperature than when prepared in crucibles, and is therefore in a more liquid condition, and is easily transferred to the ordinary ladles.

An interesting offer has been made by Sir Christopher Furness, of the Middleton Ship Building Yard, England. This works met last year with a loss of about $85,000, largely due to labor troubles, and as Sir Christopher realizes the injury both to the works and to the employes of conditions bringing about such losses, he has offered the yards for sale to the trade unions at a price to be decided upon by independent assessors. If this offer is not accepted, he offers an alternative proposition, agreeing to issue to the men preferred shares in the company, to be paid for by a deduction, from week to week, of five per cent of the wages. These shares would receive a fixed rate of interest of four per cent; whether the common shares received any dividend or not, and when the common shares receive five per cent as a yield on the capital investment, the balance of the profit is to be distributed between the common and the preferred stock. This experiment will bear watching, as it is a step toward that cooperation in the industries, which may be inevitable, in some form or other, in order to obtain industrial peace within industries organized on a large scale.

At the time of the discovery of the Taylor-White process of treating tungsten steel so as to greatly increase its cutting qualities, it was asserted in one of the English engineering journals, that the discovery was nothing new. Certain steel makers in England had anticipated the discovery, but, strangely enough, had not realized the commercial importance of the steel, and had taken no steps to put it on the market, contenting themselves with its use in their own work. The same discovery appears to have been made in the United States. A certain manufacturer of files and rasps had developed a high-speed steel for cutting files some time before the discovery of the Taylor-White process. It was not, of course, as efficient as present high-speed steels, but was far in advance of the carbon steels or air-hardening steels then in general use. In none of these cases does it appear that the importance of the discovery was recognized until Mr. Taylor and Mr. White demonstrated the tremendous increase in machine shop production that could be realized by using this steel for lathe and planer tools. A true discoverer is one who recognizes the value of his find and who makes it known to others so that there can be a common benefit derived from it.

The pyrometer for hardening and tempering steel is coming into general use. It does away with guess-work and enables the hardener to exactly reproduce a desired hardness and temper with a given brand of steel, as many times as is desired and whenever wanted, but the pyrometer is still an unknown instrument with many hardeners who are nevertheless doing good work without it. Being deprived of a pyrometer does not mean that the hardener is necessarily obliged to work by "judgment" and guess-work entirely. A simple test can be made of a brand of steel which will soon develop the proper temperature, as determined by the eye, which gives the best results. This test, mentioned in a booklet issued by the Halcomb Steel Co., Syracuse, N. Y., consists simply in taking small samples from a bar of steel and applying two or three different hardening heats. After hardening, break the samples and note the fracture. The heat

producing the finest grain, obviously, is the proper heat at which to harden that grade of steel. This, of course, applies to carbon tool steel. In this connection it may be mentioned that the Union Twist Drill Co., Athol, Mass., applies the fracture test to every bar of tool steel used. Thin disks are sawed from the ends of each heavy bar, and are hardened at the standard temperature which repeated tests have determined to be the best hardening temperature for the brand of steel employed. If the samples do not show the required fineness of texture in the fractures, the steel is rejected. It is no uncommon occurrence to find bars of steel which show different grades of fracture at opposite ends.

In the April, 1908, issue the use of an ordinary magnetic compass for ascertaining proper hardening heats for carbon steel tools was described by Mr. George T. Coles, with an illustration of use. This simple method has attracted much favorable attention, and is being practiced by many tool hardeners who have found it convenient and reliable. An extension of the idea has been patented in England, which has a certain advantage over the compass method. The drawback to the compass method is that the determination of the heat is in a sense, negative in character, the operator not receiving a definite warning the instant when the proper heat has been reached. All he knows is that when the tool has reached the hardening temperature it no longer attracts the compass, but he has no proof that it is not many degrees higher, except the heat appearance. This defect is overcome in the device referred to. An ordinary horseshoe magnet is provided with iron wire extensions to the poles, the poles being drilled axially before hardening and magnetization. A small horseshoe magnet will attract and hold small objects applied to the ends of the wire extensions, even though they are three or four inches in length. The pieces to be hardened are thus held magnetically at the extremity of the iron wire extensions in a blow-pipe flame over a jar of brine until they have acquired the proper hardening heat, when they drop off into the brine, having lost their magnetic attraction for the wires. The use of the wires, of course, is simply an expedient to avoid heating the magnet and causing destruction of its magnetic property, as would surely result if it was inserted in the flame directly. The process is automatic, but, unfortunately, it can be applied only to comparatively small parts, unless large, expensive and cumbersome apparatus is provided.

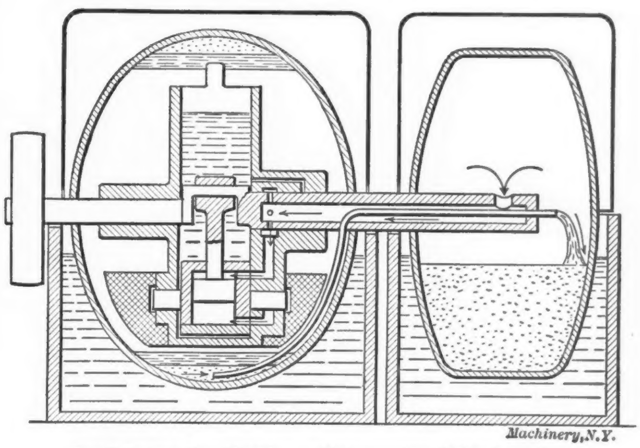
An interesting machine for testing rail wear is described and illustrated in the *Railway and Engineering Review* of October 24, 1908. Such a machine has been a subject of discussion for many years, and many ideas have been proposed, but few, if any, have ever taken practical shape. An exception to this general statement may be noted in the machine devised by the engineering department of the Pennsylvania Steel Co., and exhibited at the recent convention of the American Street and Railway Engineering Association. The apparatus is intended to test the relative wear of rails of different grades of steel. The test is conducted by bolting the rails to a circular cast iron base 20 feet in diameter, the rails forming a continuous circle. On these rails two car wheels, mounted at the ends of a heavy beam rotating on a pivot, are continuously running. A compression spring is mounted on the top of the revolving beam, which can be adjusted so as to exert pressure from zero to about 60,000 pounds on each car wheel. The vertical pressure exerted by each car wheel due to the dead load is about 7,500 pounds, so that by means of this apparatus a vertical pressure of about 67,500 pounds can be exerted on the head of the rails. In addition to the vertical pressure, lateral pressure is also exerted by means of compression springs mounted on the axle of each wheel, the maximum lateral pressure being from 15,500 pounds at 10 R.P.M., to 47,800 pounds at 85 R.P.M. The maximum speed at which the machine is designed to run is 85 R.P.M., which would correspond to a train speed of practically 61 miles per hour. As the conditions under which this machine will test the rails are very similar to those to which rails are subjected in the work, the machine will undoubtedly be of advantage in settling the question of rail wear.

A NEW ICE-MAKING MACHINE FOR DOMESTIC USE.

Scientific American, October 17, 1908.

Nearly all ice-making machines depend for their operation upon the property of certain substances to absorb a large amount of heat when changing from the liquid to the gaseous state. As a rule, anhydrous ammonia is the substance used, and this is forced through a closed cycle consisting of a compression chamber and an expansion chamber. In the latter chamber the ammonia expands into a gas, absorbing heat as it vaporizes. Then it is drawn into the compression chamber by a pump and compressed into a liquid, only to flow back into the expansion chamber and expand into a gas. Thus one chamber of the machine is made cold by the vaporizing ammonia, while the other develops heat because of the compressing of the gas. The heat from the compression chamber is dissipated by a radiator system, while the influence of the expansion chamber can be extended at will by a system of pipes through which brine is circulated.

The difficulty with refrigerating machines as commonly constructed is that long stuffing boxes are necessary to prevent leakage of the ammonia, and the friction developed in these stuffing boxes not only absorbs energy, but generates additional heat. The smaller the machine, the more serious are these losses, because of the pressure that must be maintained, which does not permit the friction to diminish in proportion to the capacity of the machine. For this reason, refrigerating machines for domestic use have not been as economical as those of large plants.



Small Rotary Ice Machine, which requires Little Attention.

Recently a machine has been invented by Prof. Audiffren, of Paris, based on the same principle as the ordinary ice machine, but so designed as to do away with all stuffing boxes, pressure gages, agitators, valves, or anything that would require the attention of an operator. As shown in the accompanying sectional view, it consists of two chambers or drums, which are connected by a hollow shaft. A solid extension of this shaft passes through the larger chamber, and at its outer end carries a pulley, which provides means for operating the machine. The shaft is sealed into the chambers, so that as the pulley revolves, the chambers revolve as well. Mounted to swing freely on the shaft within the larger drum is a small pump, which is kept vertical by means of a lead weight attached to its lower end. The piston of this pump is connected to a crank offset in the shaft, so that when the pulley is rotated, the shaft revolving with it will operate the piston. In the smaller machines the drums are charged with anhydrous sulphurous acid instead of ammonia. The pump serves to draw the gas from the smaller or expansion drum through the tubular shaft, compress it into a liquid, and discharge it into the larger or compression drum, whence it flows back through a pipe leading through the tubular shaft into the expansion drum. Here the liquid evaporates, and is returned to the compression chamber by the action of the pump. In order to provide sufficient lubrication, the pump is kept swimming in oil, the pump being fitted with a reservoir capable of carrying half a gallon of oil. The oil cannot escape, and such of it as leaks out of the pump is trapped and returned to the reservoir. Owing to the rapid rotation of the drum, the liquid acid is centrifugally

thrown against the inner periphery of the chamber, and any oil that leaks into the chamber is centrifugally separated from the heavier sulphurous acid, forming an annular layer within the acid layer. The illustration shows the acid and oil at the bottom and top of the compression chamber. At the top of the oil reservoir is a scoop, which extends upward sufficiently to dip into the oil, but without reaching the layer of sulphurous acid. This scoop collects the oil, causing it to fall back into the reservoir.

The expansion drum rotates in a small tank partly filled with water, and this forms a layer of ice over the drum when the machine is in action.

ELECTRIC HARDENING FURNACES.

C. R. Straube in the *Elektrotechnische Zeitschrift*, August 6, 1908.

In externally-fired furnaces, the heat losses are always considerable, and only a small part of the energy used in heating is utilized for raising the temperature of the metal to be hardened. There is also a disadvantage in employing gas or oil-fired furnaces in that the high temperatures rapidly destroy the crucibles. Electric hardening furnaces, therefore, possess marked advantages for this work over the various types of externally-fired furnaces. The electric furnace described in the following has been brought out by the Allgemeine Elektrictäts-Gesellschaft of Berlin, Germany. A bath of melted metallic salts is contained within a fire-brick crucible, inside of which, at two opposite sides, are fixed electrodes of iron very low in carbon, the melting point of which is higher than that of ordinary steel. This crucible is surrounded by a thick layer of asbestos, which is, in turn, imbedded in a layer of some heat-insulating material, the whole being held together by a steel case. The walls of the furnace are made so thick in relation to the dimensions of the crucible that the steel case of the apparatus may be touched with the hand without injury after having been in operation for 10 hours, at a temperature of 2,370 degrees F.

The soft iron supply conductors to the electrodes are connected to the secondary copper bars of a regulating transformer which transforms the normal voltage to the low voltage (5 to 70 volts) employed in the operation of the furnace. A typical arrangement of the equipment of a large works has the furnaces provided with a hood in a central position, and a quenching tank immediately beside the furnace on one side. By this latter arrangement a change in temperature caused by carrying pieces from the furnace to the water tank is reduced to a minimum. The tank is supplied with heating and cooling coils with steam or cold water, so that the temperature of the quenching bath can be easily regulated.

A pure metallic salt or a mixture of several salts is placed in the crucible and melted by the passage of an electric current. Potassium chloride which fuses at about 1,425 degrees F. is selected for carbon steel; for high-speed steels, barium chloride, which fuses at 1,740 degrees F., is employed. Mixtures of these two salts will give all intermediate temperatures. For low temperatures, say between 400 and 750 degrees F., postassium and sodium nitrates may be used, and for very high temperatures, magnesium fluoride and fluorspar. The salt is melted by a movable electrode and a small piece of arc-light carbon placed in the circuit between one of the fixed electrodes and the movable one. Sparking between the carbon and the movable electrode causes salt immediately adjacent to melt and very soon a circuit is set up through a part of the salt. As the movable electrode is gradually drawn away, it leaves behind a streak of melted salt, which is extended by degrees to the opposite electrode. When this point is reached, the fusion of the remainder of the salt proceeds at a rapid rate. The temperature produced depends on the voltage employed, and may be varied by changing the intensity of the current, which is accomplished by means of a regulating transformer.

Even at a temperature of 2,400 degrees F., attainable in laboratory tests but not usually employed in commercial hardening, the damage to the crucibles of the electric furnace is very small. Working ten hours a day with this temperature, a crucible will last six months, and for ordinary hardening temperatures, fifteen months.

EFFICIENCY TESTS OF MILLING MACHINES AND MILLING CUTTERS.

Abstract of Paper by Mr. A. L. DeLeeuw, read before the American Society of Mechanical Engineers, December, 1908, Meeting.

The design of standard machine tools was for many years, and has been until quite recently, a matter of practical experience, judgment and intuition, and might as well have been called guesswork. Special tools of unusual magnitude were built on somewhat more scientific principles, and this, perhaps, simply because the required dimensions were quite out of the scope of the designer's experience. It was not quite so easy to show judgment about a 6-inch as a 1½-inch lead-screw; and it would not have done at all to make the screw 12-inch just to make sure; though the instances are

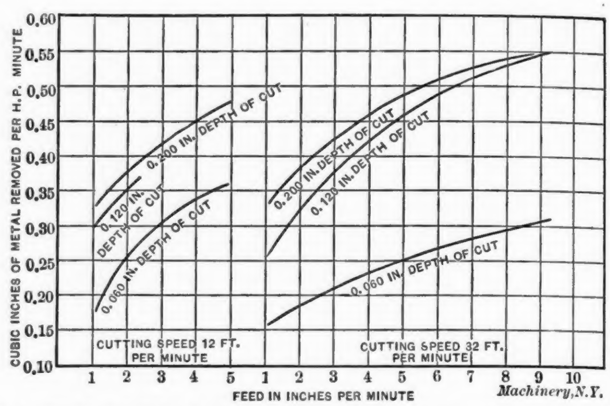


Fig. 1. Work of 1 H.P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

not at all rare when some machine part, screw or shaft, on some smaller machine was made double the required size, simply to be on the safe side.

This condition was not due to ignorance on the part of designers or inability to apply engineering data, but to the fact that such data did not exist or were not public property when they did exist. Further, there was no inducement for the machine tool builder to spend time and money collecting data, as the tools, as built, filled all requirements to a reasonable extent.

This condition ceased to be satisfactory with the coming of the electric motor into the field of the machine tool builders. At first the wildest and most varied guesses were made as to the size of motor required to drive a certain tool. One

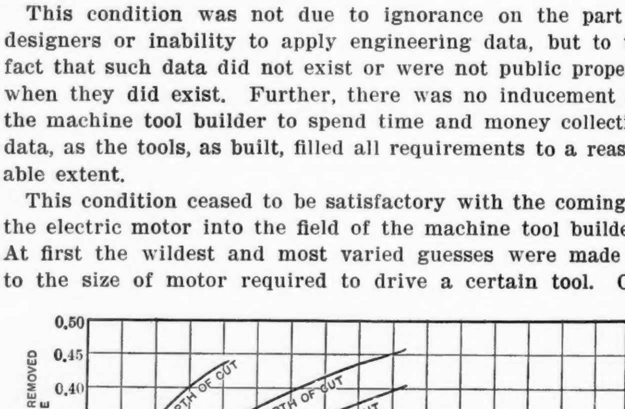


Fig. 2. Work of 1 H.P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

builder would supply his machine with a 2½ H.P. motor, while another would equip the same size and style of machine with a 15 H.P. motor. This chaos was made worse by the fact that most purchasers of motor-driven tools would specify the size of motor to drive the machine. One user would condemn the machine tool builder because the 10 H.P. motor was entirely too small, and the next one because a 5 H.P. motor was much too large for the same machine.

This brought before the machine tool builder the fact that a machine was not always used to its full capacity and was sometimes badly overloaded. In sheer self-defense the machine builder was compelled to determine for himself the proper size of motor to be put on his machine, and he began to make tests and collect data; but although numerous tests have been made as to performance of machine tools, they have been confined almost exclusively to lathes. All other

machines seem to have been considered as following the lathe in cutting characteristics.

The author of the paper here abstracted therefore found it necessary to undertake a number of tests directly applied to milling machines, in order to collect data preliminary to the designing of a line of horizontal and vertical milling machines for the Cincinnati Milling Machine Company.

Specifications of Milling Machine Tests.

The main points to be settled were:

a. How much metal shall a machine of given size be capable of removing?
b. How much power is required for this work on existing machines?
c. Is it possible to improve on the efficiency of present machines and still produce a commercially successful machine?
d. How much power is required for the feed?
e. What is the efficiency of the feed mechanism?

The first question was a point to be decided by the sales manager rather than by the engineer, as it was greatly a matter of competition. As is quite usual in the design of a new line of machines, the desired capacity was placed somewhat higher than that of other makes of similar machines. To determine how much power was required to remove a given amount of metal, tests were made on various makes of machines. The metal to be cut was in all cases, both in these tests and in those to be described later, steel of the following specifications: carbon contents, 0.16 per cent; tensile strength per square inch, 52,378 pounds; limit of elasticity, 30,313 pounds.

The test blocks used were 18 inches long, 5½ inches wide and 5½ inches thick. The ends were milled to provide means

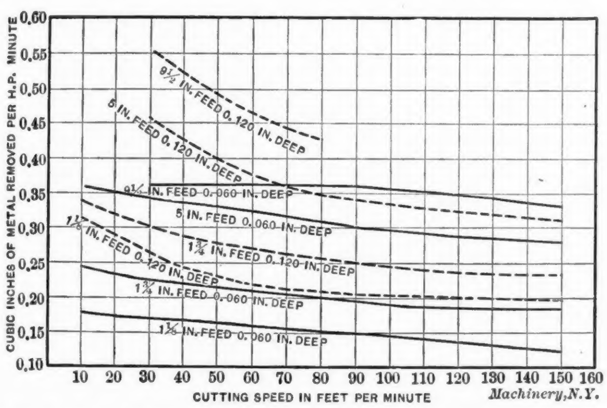


Fig. 3. Work of 1 H.P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

for holding the block on the table of the milling machine. In all tests a spiral cutter with nicked teeth was used, 3½ inches in diameter, 6 inches face, and for a 1½-inch arbor. The cutter was driven by a key, and made of high speed steel. All tests were made by driving the machine by an electric motor, belted to the machine. The object was to have all conditions as near as possible to those under which the majority of milling machines have to run, the only difference being that the belt was nearly horizontal instead of vertical. In testing the efficiency of machines in this way, the belt must be considered part of the machine. The power consumed was ascertained by reading of ammeter and voltmeter, the amount of metal removed, by measuring width and depth of cut, and the amount of feed per minute, was computed from the gearing.

These preliminary tests showed considerable differences in the efficiency of different makes of machines; that is, one machine would cut considerably more material than another for a given amount of horse-power developed by the motor. They also showed that the efficiency of these machines was relatively low as compared to the lathe. This latter might have been expected considering the nature of the cutting tool. As the main problem in a machine shop is not to save power, but to get the greatest possible output, this lack of efficiency cannot be held up against the milling machine as a type, for its other peculiarities make it highly efficient as a producer of work. The fact that one make is so much more efficient than another is of great importance, however. It shows that the less efficient machines:

a. Use a needlessly large amount of power.
b. Have less capacity than they might have for removing metal.
c. Use a large amount of power constantly for the purpose of breaking down the machine.

It follows that it should be the aim of the designer to produce a machine of the highest possible efficiency as a power transmitter, because

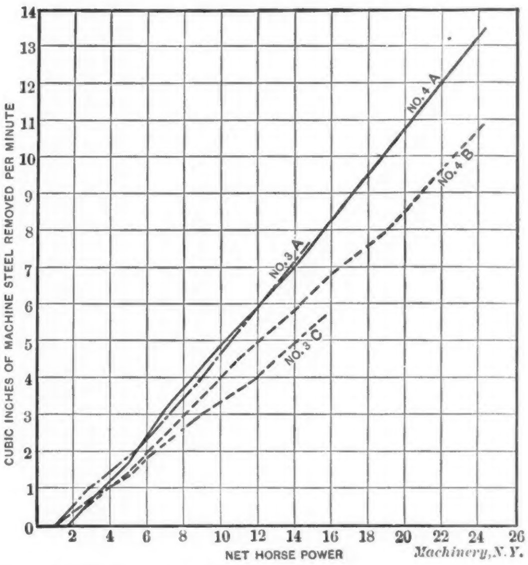


Fig. 4. Diagram showing Relation between Horse-power required and Metal removed.

a. This increases the capacity of the machine.
b. It insures long life and freedom from repairs.
c. It is economical in the use of power.

This high efficiency requirement stands by itself. It must be supplemented, however, by other good features, such as convenience, etc. The main features aimed at, and considered essential to high efficiency, were the following:

a. Absence of combined torsional and bending stresses in shafts.
b. Absence of torsional stresses in shafts subjected to heavy loads.
c. Moderate gear speeds.
d. Moderate shaft speeds.
e. Minimum number of gears in action.

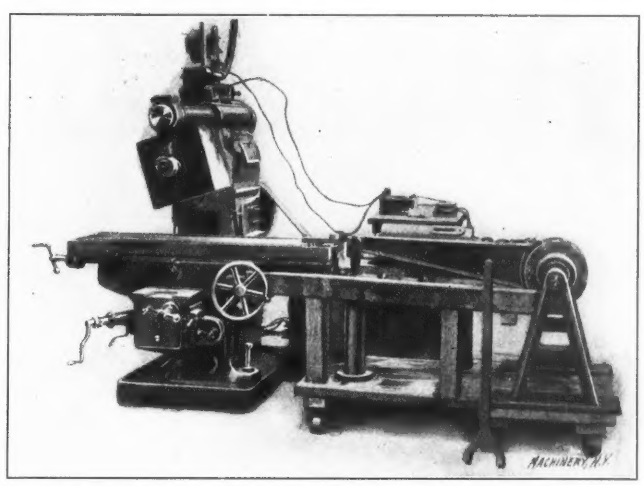


Fig. 5. Apparatus for Testing Efficiency of Feed Mechanism.

f. No gears rotating, which are not required for the transmission.
g. Tumbler bearing anchored solidly, and not merely hung from a lever.
h. Pulley shaft relieved of belt pull.

Final Tests.

More complete tests were made when the machine designed along the lines mentioned was completed. These tests were of three kinds:

a. Tests determining the amount of metal removed per horse-power.
b. Tests determining the efficiency of the feed mechanism.

b. Tests determining the efficiency of the feed mechanism.
c. Tests determining the efficiency of the driving mechanism.

Power Required to Remove Metal.

The same motor and belt were used for all cutting tests. A series of tests was made with a depth of cut of 1/16 inch; then with a depth of 1/8 inch; then 3/16 inch, 1/4 inch, and

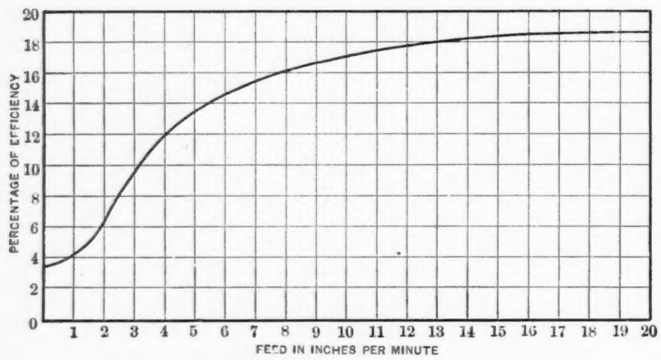


Fig. 6. Curve showing Efficiency of Feed Mechanism.

3/8 inch. This complete test was repeated four times. The cutter was sharpened in the ordinary way before starting a complete series of tests, and not resharpened during the test. The same cutter, resharpened, was then used for the next machine. For each depth of cut, a number of different feeds were used.

The amount of power required to remove a given amount of metal varied with the speed, depth of cut and feed per minute, and seemed to have a tendency to the minimum when the section of the chip removed per tooth approached most nearly a perfect square. Figs. 1, 2, 3, and 4 show curves giving relation between power required and metal removed under different conditions of speed, feed and depth of cut. The fact that the power required changes with these conditions of feed, speed and depth of cut made it impossible to plot a single curve giving relation between power and metal removed. The curves were extended to the zero point, but the high point of all curves is the actual highest average obtained, so that in a certain sense the curves also show the comparison of the greatest possible capacity of these machines. This should be taken as significant, however, only when remembering the conditions under which the machines were tested, and then only as a measure for the maximum driving power.

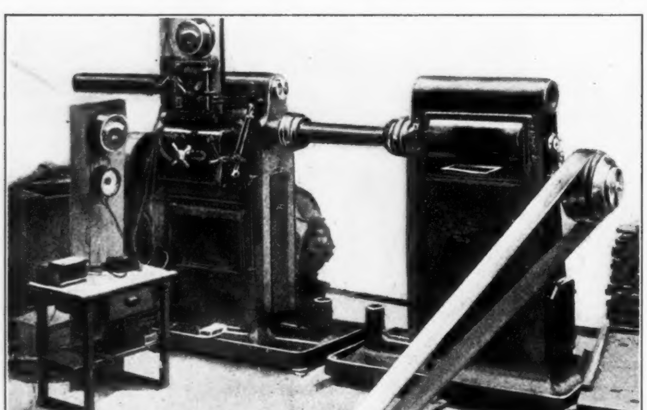


Fig. 7. Apparatus for Testing Efficiency of Driving Mechanism.

Efficiency of Feed Mechanism.

Fig. 5 shows the manner in which the machine was rigged up for testing the efficiency of the feed mechanism, and Fig. 6 shows the curve of average values plotted from the tests; each ordinate is the average of the ordinates corresponding to a certain amount of feed. The results of these tests justify again the precaution taken to obtain an efficient feed mechanism in the new line of milling machines. It may be mentioned here that these precautions consisted in avoiding idle running gears, high gear velocities, combined torsional and bending stresses in shafts, and ill supported and floating bearings, and above all, the use of quick pitch screws.

Tests upon Efficiency of Driving Mechanism.

The third series of tests relates to the efficiency of milling machines as power transmitting devices: that is, the ratio of "input" and "output" of power. Some preliminary tests were made by observing the power at the spindle by means of an absorption brake of the Weston type. This gave fairly good results at the higher speeds, the torque being small; but at the lower speeds and with greater torque the action of the brake became jerky and it was practically impossible to obtain reliable readings. The tests were carried on with the apparatus shown in Fig. 7. This consisted of two machines of the same type, make and size placed opposite each other and connected by a stout shaft. The feed works were removed, as were also knee, saddle and table, so that nothing was left but the bare frames and driving works. The machines were placed with the spindles approximately in line. A flange was screwed to the nose of each spindle; each flange was provided with a tongue engaging the groove in a similar flange opposing it, and keyed to the stout connecting shaft. There was plenty of clearance between tongue and groove and also endwise so that the connection could behave as a universal joint shaft in case the spindles were not exactly in line. It must be remarked here that the motion in this universal joint shaft was exceedingly small. Flat pieces of steel bolted to the first mentioned flange prevented the connection from coming apart.

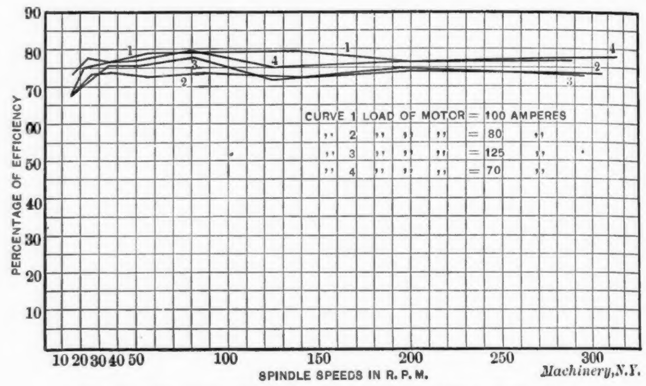


Fig. 8. Diagram of Efficiency of Drive of Milling Machines.

One of the machines was driven by a motor while the other drove a generator. The current thus generated was dissipated in a water rheostat, by means of which the amount of current could be closely regulated. There was a set of electric instruments for motor and generator each, so that all readings could be taken simultaneously. Both machines were driven by belts. A tachometer was used to determine if one of the belts slipped excessively. If the generator voltmeter showed considerable drop and the tachometer showed about the proper speed at the first driving shaft of the first machine (motor machine), then the belt to the generator must have slipped. If, however, the tachometer showed a drop, then the belt from the motor to the first machine must have slipped. The speed controlling levers of both machines were always in corresponding positions—that is, both were set for the same speed, so that at whatever speed the spindle was running, both driving pulleys were always running at the same speed, and that is the speed at which they are supposed to run under working conditions. The results of the tests are shown in Fig. 8. It will be seen that the efficiency of the machine varies from 67 to 79.7 per cent.

Efficiency of Cutters of Different Types.

The milling machine is not essentially less efficient as a power transmitter than any other machine tool, but the amount of metal removed per horse-power per minute is low; much lower in fact than for the lathe or planer. Were it not for other properties, the milling machine could not compete with either of these two machines. Still it cannot be denied that the milling machine would be esteemed higher if its power consumption could be brought down to the level of

the lathe. It is obvious that this cannot be done by increasing the efficiency of the mechanism, as the margin is not large enough to allow of any material improvement. Any substantial increase of efficiency must therefore be found in improvements of the cutting tool. With this consideration in mind, some tests were made as to the power required to remove a given amount of metal with different styles of cutters.

Cuts made with a spiral cutter with nicked teeth showed a best efficiency of 0.48 cubic inch of metal per net horse-power per minute, and this efficiency was obtained only in a

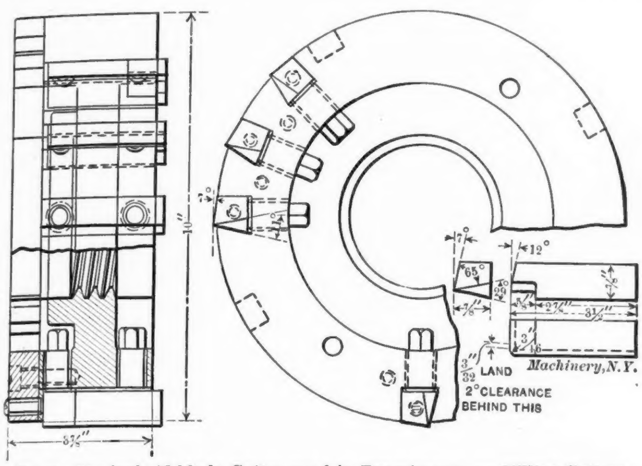


Fig. 9. Ten-inch, 16-blade Cutter used in Experiments on Milling Cutters.

few isolated cuts and with a very sharp cutter. Cuts made with a 14-inch face cutter with inserted teeth and on a No. 4 Cincinnati high power miller showed a production of 0.64 cubic inch per net horse-power per minute, an increase of 33 1/3 per cent over the spiral cutter. This result confirms the general belief that a face cutter cuts freer than a spiral cutter. The teeth of this face cutter were radial, as it is customary to make them. Tests made with the cutter shown in Fig. 9 showed an efficiency of 0.96 cubic inch of metal per net horse-power per minute, and a few isolated cuts even higher. This is an improvement of 100 per cent over the spiral cutter and 50 per cent over the face cutter with radial teeth. The cutter shown in Fig. 10 showed the same efficiency. Both cutters have the blade set tangent to a circle concentric with the cutter, thus giving them a rake angle of 15 degrees. The clearance was 7 degrees. The points of

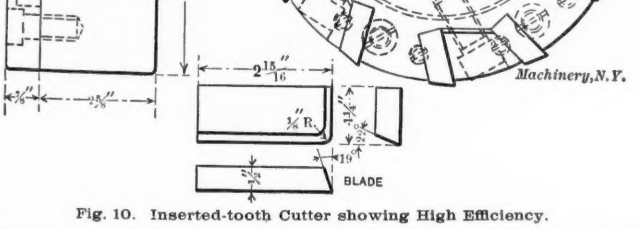


Fig. 10. Inserted-tooth Cutter showing High Efficiency.

the cutting blades were rounded to prevent injury by burning or chipping, and this reduced the effective rake near the horizontal tangent to this curve. It was for this reason that the blades were set leaning backward as in Fig. 10. But for this curvature at the point of the blades, the simpler construction of Fig. 9 would be perfectly satisfactory. The leaning back of the blades is rather a refinement than a necessary improvement.

It should be borne in mind that the tests made with these cutters were made on a vertical machine which had the same driving parts as a horizontal machine of the same size, and besides an additional two shafts and four gears, so that it is safe to say that its mechanical efficiency must be less than that of the No. 4 horizontal machine used with the spiral cutter with nicked teeth. The action of the feed on a machine using this cutter may be somewhat different from that on a machine using spiral cutters. Whether there is such a difference and what it amounts to, has not been ascertained by tests, and might be a promising field to explore. The fact that, generally speaking, the face cutter with rake removes double the amount of metal with the same amount of power as compared to the spiral mill, is significant, and places the vertical machine in the front rank for slabbing work wherever it is possible to use this type. Equally significant is the fact that a cutter with rake removes 50 per cent more metal than a cutter without rake. It may be mentioned here that many of these cutters, especially for so-called rotary planers, are being made and have been made for a great many years with the teeth leaning backward as in Fig. 10 but without rake; the makers and users apparently believing that this leaning constitutes rake.

[In the May, 1906, issue of MACHINERY, Mr. DeLeeuw commented on the subject of making milling cutters without front rake. It is interesting to note how correctly the results of actual experiments bear out the opinions then expressed.—EDITOR.]

* * *

CONSTANTS FOR CALCULATING HELICAL GEARS.

C. W. PITMAN.*

The calculation of helical gears always is a time-consuming operation, and any short-cuts or labor-saving methods, proposed from time to time, are eagerly accepted by designers. The working out of a table of constant factors which can be applied directly to the various requirements of the design, opens up one of the easiest and shortest roads to the solution of helical gear problems known to the writer, and such a table has therefore been computed and is presented in the accompanying Supplement. The use of this table will reduce very materially the time necessary for the computation of the angles, dimensions, etc., of helical gears, as well as greatly simplify the calculations.

The body of the tables in the Supplement gives constants C_t for center distances of shafts for each speed ratio given, the shafts being at right angles, while the factors U, F, and L are equally applicable to gears on shafts at any angle. The constants for unit diameter of gear per tooth, U, and for unit center distance per tooth of fast gear, C_t, are calculated for gears cut with spur gear cutters of 1 diametral pitch; for any other pitch divide the constant by the diametral pitch of cutter used. The factors C_t given in the body of the tables, are, it should be noted, per tooth of fastest running gear, or gear having the smallest number of teeth. All factors are given for each degree (from 12 to 78 degrees) of angle of tooth helix. For angles including a fractional part of a degree, while strict accuracy would require the use of interpolation formulas, test calculations have shown that the proportional value between factors, as used in the examples given later in this article, is sufficiently accurate to meet all practical requirements.

The simplicity of the operation of calculating a pair of spiral gears will be apparent from an example: Required the number of teeth, diameters, and center distance, for a pair of gears, helix angle of pinion 60 degrees, of gear 30 degrees, speed ratio 2 to 5, and teeth of 6 diametral pitch.

The following notation will be used in the formulas:

N_a = number of teeth in pinion (gear having the smallest number of teeth),

P_d = diametral pitch,

C_t = center distance per tooth (1 diametral pitch) of pinion, as given in tables in Supplement,

U = unit diameter per tooth (1 diametral pitch), given in the Data Sheet Supplement,

L = lead of tooth helix per inch pitch diameter, given in Supplement,

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D = pitch diameter,

F = cutter factor, as given in Supplement.

From Table II in the Supplement, we find the factor C_t for this angle and speed ratio to be 2.4435, and by the formula $N_a \frac{C_t}{P}$ = center distance, and disregarding for the moment the number of teeth, we have $\frac{2.4435}{6} = 0.40725$.

If we wish a center distance of approximately 5 inches, we will use a value of $N_a = 12$; this gives us

$0.40725 \times 12 = 4.887$ inches center distance; 12 teeth in pinion; and $12 \times \frac{5}{2} = 30$ teeth in gear.

For the further calculations, using the formulas given below, and the factors for the angles stated, we have:

$\frac{U \times N_a}{P_d} = \frac{2 \times 12}{6} = 4$ inches pitch diameter of pinion,

$L \times D = 1.814 \times 4 = 7.256$ inches lead of tooth spiral of pinion,

$F \times N_a = 8 \times 12 = 96$, thus requiring No. 2 cutter for pinion.

Using the same formulas for the gear gives us:

$\frac{1.1547 \times 30}{6} = 5.774$ inches pitch diameter of gear,

$5.441 \times 5.774 = 31.416$ inches lead of spiral of gear,

$1.54 \times 30 = 46$, requiring No. 3 cutter for the gear.

From the above it will be at once apparent that the tables giving as they do constants for finding all data necessary for the sizing and cutting of the gears, permit a great saving of time over any other method, whether graphic or by calculation. In fact, by their use the task is rendered practically as easy and as simple as the figuring of a pair of spur gears, and the novice can do this work as well as the expert.

The above solution meets the conditions involved in probably nine out of ten spiral gear problems, that is, where the center distance of shafts is adjustable, and the helix angle can be taken at will. Occasionally, however, it becomes necessary to calculate the gears to suit a fixed center distance, in which case the helix angle must be made to suit the other conditions. This has always been a tedious and time-consuming operation, but the use of the table cuts out the drudgery, and reduces the time required to a minimum.

For instance, suppose in a machine having the above gears, it were required to replace them with others having a speed ratio of 1 to 2, without changing the position of the shafts. Transposing the formula for center distance and solving, we have

$$C_t = \frac{P_d \times \text{center distance}}{N_a}$$

and using for trial the same number of teeth in the pinion as before,

$$C_t = \frac{6 \times 4.887}{12} = 2.4435.$$

Inspection of the tables in the supplement shows that this corresponds to an angle lying between 68 and 69 degrees; this might do, but a smaller angle is preferable; trying 14 teeth, we have

$$C_t = \frac{6 \times 4.887}{14} = 2.0945.$$

This gives an angle of 55 degrees 15 minutes for the pinion, and is much better; for the gear we have 28 teeth, and a helix angle of 34 degrees 45 minutes, and using the proportional value between factors U for these angles, gives by the formula for pitch diameters,

$\frac{14 \times 1.7546}{6} = 4.094$ inches, pitch diameter of pinion,

$\frac{28 \times 1.2171}{6} = 5.679$ inches, pitch diameter of gear.

While the range of speed ratios given is sufficient to meet nearly all requirements, gears can be as readily calculated, and the center distances then found, for any other ratio. Thus, for a pair of gears of 4 pitch, 19 and 20 teeth, helix angles 45 degrees, we have, by the formula for gear diameters:

$\frac{19 \times 1.4142}{4} = 6.717$ inches, pitch diameter of pinion,

$\frac{20 \times 1.4142}{4} = 7.071$ inches, pitch diameter of gear, and

$\frac{6.717 + 7.071}{2} = 6.894$ inches, center distance.

For shafts at other than a right angle the factors C_t do not apply, and for fixed centers the proper helix angles can be found only by repeated trials. Where the center distance can be made to suit diameters, however, as is usually the case, the process is very simple. Thus, for shaft angle 65 degrees, speed ratio 1 to 4, gears 8 pitch, we have:

Pinion, 8 teeth, 30 degree helix angle;

Gear, 32 teeth, 35 degree helix angle.

$\frac{U \times N_a}{P_d} = \frac{1.1547 \times 8}{8} = 1.1547$ inch, diameter of pinion;

$\frac{1.2208 \times 32}{8} = 4.8832$ inches, diameter of gear.

Center distance $= \frac{1.1547 + 4.8832}{2} = 3.0189$ inches.

The lead of spiral and the cutter to use for milling the teeth will be found as in the first example.

For helical gears on parallel shafts the table will also be found a great convenience, as it reduces the necessary calculations to a minimum. The constants given in the body of the table do not apply for these gears, since the helix angle of both gears of a pair is the same, and their diameters are therefore proportional to their velocities. For example: suppose a speed ratio of 1 to 5, helix angle 15 degrees, 8 diametral pitch. Using 14 and 70 teeth for pinion and gear respectively, we find by formula

$\frac{U \times N_a}{P_d} = D,$

$\frac{1.0353 \times 14}{8} = 1.812$ inches, diameter of pinion,

$\frac{1.0353 \times 70}{8} = 9.059$ inches, diameter of gear, and

$\frac{1.812 + 9.059}{2} = 5.436$ inches center distance.

If it were desired to replace these with gears of 6 pitch, speed ratio and center distance the same, the diameters would obviously be the same, and the helix angle must be found; transposing our formula, we have

$$\frac{D \times P_d}{N_a} = U.$$

For N_a we must assume a value, but as the helix angle for these gears is generally kept as small as possible, the number of teeth in the smaller gear of the pair will always be taken at the nearest whole number less than $D \times P_d$; therefore

$$\frac{1.812 \times 6}{10} = 1.0872 = U.$$

Consulting the table we see that this value of U will give an angle of 23 degrees 6 minutes. The leads and cutter to use are found as follows:

For the pinion, 10 teeth,

$7.367 \times 1.812 = 13.338$ inches lead of tooth spiral,

$1.28 \times 10 = 13$; use No. 8 cutter.

For the gear, 50 teeth,

$7.367 \times 9.059 = 66.737$ inches lead of tooth spiral,

$1.28 \times 50 = 64$; use No. 2 cutter.

METAL-CUTTING TOOLS WITHOUT CLEARANCE.*

The principles of a turning tool intended to cut without clearance, consisting of a cutter and a holder so constructed as to allow the cutter a slight oscillatory freedom in the holder, are discussed in the following: The center line on which the cutter oscillates is substantially coincident with the cutting edge. The oscillation of the cutter about the center line does not affect the position of the edge, but allows the face of the cutter to swing around to conform to the face of the metal from which the chip is being severed. The objects of this construction are to make possible the use of more acute cutting edges to reduce the cutting stresses; to wholly or partly equalize the unbalanced side pressure on

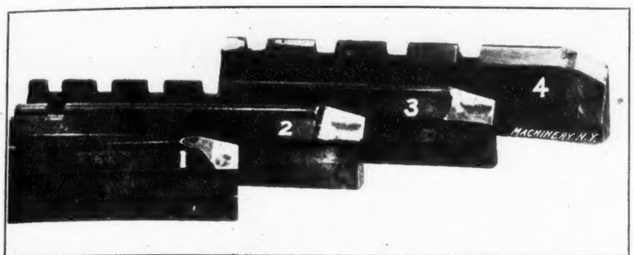


Fig. 1. Illustration showing the Abrasive Contact of Chip on the Top Slope. Nos. 1, 2 and 3 were used in Tool-holder illustrated in Fig. 3. No. 4 shows one of the Earlier Forms.

the cutting edge; and to obtain a rubbing contact to prevent lateral vibration.

In order to make clear the reasons for the construction of the tool shown, it will be necessary to briefly analyze some of the conditions under which metal is worked in a lathe, dealing particularly with cutting angles, clearance of cutting edges, and the importance of minimizing the tendency of the work and tool to separate under cutting stresses. The subject has been approached from the standpoint of a designer and manufacturer of lathes, and particularly lathes of the "flat turret" lathe type.

The generally accepted cutting angle of greatest endurance under high speed is about 75 degrees, and the angle of least resistance, according to some of Dr. Nicholson's tests, is about 60 degrees. The cutting angles of the tool illustrated and discussed may be varied from the present orthodox angles down to 30 degrees or less, according to the nature of the work. The results obtained by Dr. Nicholson, which showed an increase in cutting stress for tools more acute than 60 degrees, may have been due to the cuts having been taken without suitable cutting lubricant. Furthermore, the comparative lack of durability of the more acute edge below 70 degrees, may have been due either to heat or lateral vibra-

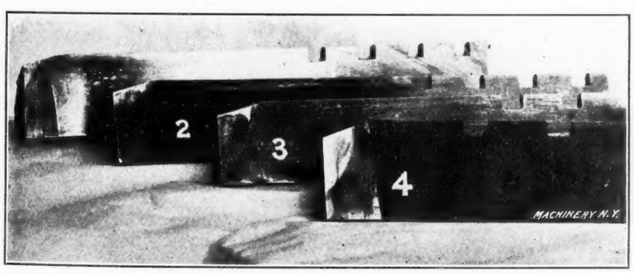


Fig. 2. Reverse Side of Cutters shown in Fig. 1. Illustration shows Rubbing Contact of the Tool against the Shoulder of the work. Each Tool bears Same Number in Both Engravings.

tion, or both. The heat would have been greatly reduced by a liquid cooling medium, especially one having some suitable lubricating qualities, and the lateral vibration may be eliminated by means to be explained. The thin edge of an acute tool is obviously the least suited to carry off heat or to withstand the vibration incident to cutting.

Class of Work Considered.

The tool illustrated should be considered from the standpoint of one who sees nothing but lathe work under 20 inches in diameter, and of the kind usually found in any machinery-building plant; not that the means may not be of value in larger work, but simply that this is out of the author's range of experience, and such work was not considered in designing the tools described. A more exact description of the range of work for which this tool is intended may be stated as follows: Lathe and turret lathe work under 20 and over 4 or 5 inches in diameter, and less than 8 or 10 inches in length; also work up to 2 and 3 feet in length of diameters under 3 to 3½ inches and generally over ¾ or 1 inch in diameter. This includes three classes of work: (*a*) chuck work, having diameter generally exceeding length, held wholly by a chuck or face-plate; (*b*) bar work, which is held in chuck and steadied by back rests; (*c*) work having dimensions similar to bar work, but which must be turned on centers, with or without following and fixed steady-rests. The material dealt with is regular open hearth machinery steel of about 20 points carbon.

In work supported on centers and in chucking work, the connection between the work and tool includes a number of joints, both for sliding the tool in relation to the work, and for the rotation of the work. Each of these joints has more or less slackness, and each of the slides and other members are more or less frail in structure. With a mounting of

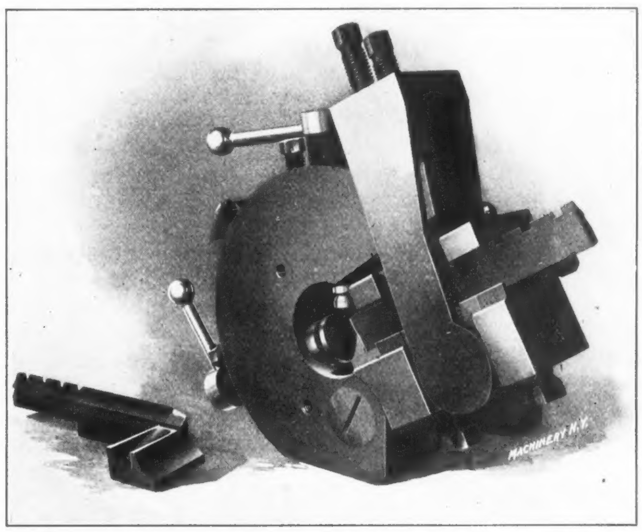


Fig. 3. The No-clearance Turning Tool for the Flat Turret Lathe.

this kind, the cutting edge of the tool does not pass through the metal without swerving and flinching.

Means for Improving Efficiency.

A machine's efficiency is proportional to its strength to resist its working stresses. There are two ways to increase this efficiency: (*a*) by strengthening the machine, and (*b*) by reducing the stresses for a given result. In the author's previous work the strengthening of the machine has been accomplished by the elimination of unnecessary features, and placing the necessary joints for obtaining the various motions in the least objectionable positions. The next step was to devise a means for minimizing the stresses at the cutting edge, and the object in view is to explain how this result has been obtained. This reduction of stresses may not be important in roughing work in which a flinching of the work or machine may be disregarded so long as the machine continues to crush off the metal, but for the kind of work mentioned above it must be considered of first importance.

Analysis of Conditions.

In the class of work under consideration each piece has several diameters, with shoulders which should be accurately spaced and formed. Nearly all the shoulders required in this class of lathe work are the so-called square shoulders. In engine lathe practice these shoulders are "squared up" by a side tool after the other turning has been done by a round nose or diamond point tool, but in the turret lathe, for bar work, these shoulders are produced by the same tool that takes the stock-removing cut. The tool used in turners for bar work cuts on the same principle as the engine lathe side tool; that is, its rake or top slope is almost wholly side

* Abstract of paper by Mr. James Hartness, read before the American Society of Mechanical Engineers, December meeting, 1908.

[The lathe tool, the principles of which are here discussed, has been developed by Mr. Hartness of the Jones & Lamson Machine Co., Springfield, Vt., for special application to the flat turret lathe manufactured by this company. It is strictly a special turning tool, and will not be furnished as a part of the regular equipment of this machine.—EDITOR.]

slope, and its cutting edge stands at an angle of 90 degrees to the axis of the work.

In the engine lathe a tool of this character has generally been unsatisfactory for rapid turning, yet in the turret lathe this very tool seems to be universally used for all bar work. The difference in performance seems to be due to the difference in mounting. It works well where there is no chance of vibration, but trouble begins when it is used in a machine like the engine lathe or turret chucking lathe in which the work is supported by one part of the machine and the tool by another, and the true path of the cutting tool through the metal is dependent on the entire structure of the machine,

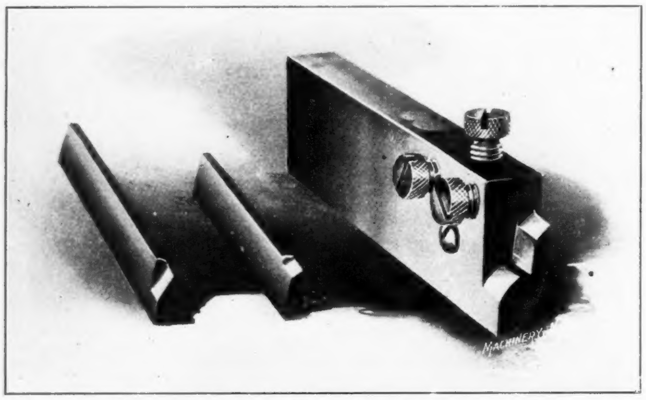


Fig. 4. No-clearance Tool for Standard Engine Lathe Tool-post, showing Three Cutters of Different Angles.

there being nothing to prevent vibration. The no-clearance tool to be described is a side tool without clearance. Its under face bears flatly against the work, thereby preventing lateral vibration.

For the purpose of analysis the cutting stress may be divided into three elements; the direct cutting stress, the separating stress, and the tendency to vibrate.

Direct Cutting Stress.

By direct cutting stress is meant that part of the stress that is directly downward in a lathe. With all other conditions unchanged, we should expect to find an acute edge tool offering the least resistance, and that the difference in direct cutting stresses for tools of varying cutting angles would show a marked reduction in favor of the more acute tools. Dr. Nicholson's experiments, already mentioned, showed an increase in cutting stresses and a marked loss in endurance, below 60 degrees, but these tests were on dry cutting without the benefit of a lubricant or cooling solution. Thin edge tools are undoubtedly benefited more by lubricant

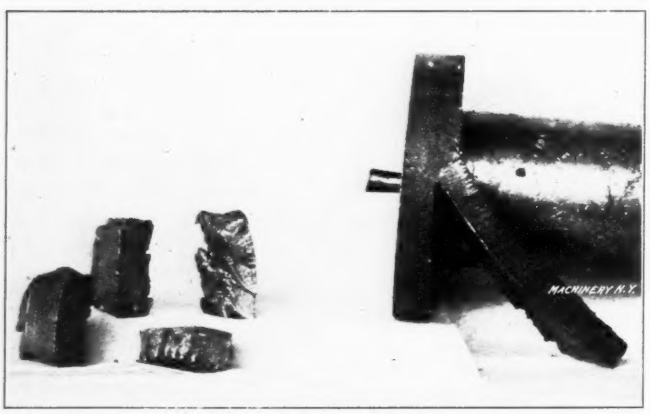


Fig. 5. Sample of Broken Chips and Work with an Unbroken Chip. This View is nearly Full Size. The Exact Dimensions of Sample are 1 3-4 Inch Diameter turned down to about 1 Inch; feed about 7 per Inch; Cutting Angle of Tool about 38 Degrees; Extreme Edge 1-32 Inch Flat. These Chips were broken by a Chip Breaker.

or cutting medium, than blunt edge tools. Just what cutting angle would be the best under conditions of most efficient cooling medium may not yet be fully known.

It is obvious that the least direct cutting stress for a given depth and feed should be obtained by a straight edge tool, and one that would take a chip in which there is the least molecular change. Crushing and partially or wholly shearing the chip into chunks which are three or four times the thickness of the feed undoubtedly increase the working stresses and heat.

A flat top slope should have a straight cutting edge. The more the edge is rounded the greater the conflict of the metal crowding onto the edge. The flow of metal on the top slope of the round nose does not move in one direction wholly, but tends to travel towards the center of the curve. The conflict of currents of metal which approach the center from various parts of the curved cutting edge, increases the direct cutting stress. The crushing process of the usual method of turning is due both to the bluntness of the cutting angle and the shape of the edge.

Separating Stress.

By separating stress is meant that stress which, in turning a shaft, forces the tool outward radially. Increasing this stress causes the work and tool to move apart, and results in variation in diameter, also in irregular and generally inaccurate product, particularly when the rough stock runs eccentric or irregular. Although this separating stress may be decreased by giving the tool more back slope, this is only possible in tools taking light depth cuts. A lathe tool, however, which takes a cut like a side tool, shows little or no tendency to separate radially. With the side tool set at an angle of 90 degrees to the travel of the feed, the feeding stress does not tend to force the work and tool apart; in fact, this tool may be set so as to produce a slightly beveled shoulder either side of the 90-degree angle so as either to draw the work and tool together when making an overhanging shoulder or to force the work and tool apart when producing an external bevel.

Vibration Stress.

The quivering stress which is due to the nature of the chip is affected by the cutting angle of the tool. The chunks which make up the parts of a chip are less firmly united

Fig. 6. Chips taken by Diamond Point Tool, 75-degree Top Slope and Slightly Rounded Nose.

Fig. 7. Chip taken by 40-degree No-clearance Tool at same Feed and Depth. Illustrations about Full Size.

in a chip taken by a tool of 70 degrees cutting angle than by a tool of 50 degrees, and, of course, the more firmly united chunks give a more continuous chip with the least vibration.

In turret lathe practice, especially in bar work, the tool and work are held together by a back rest which follows on the surface produced by the cutter, and in some kinds of turret chucking work the tools for interior work are mounted on boring-bars which take bearing either in the work or in the chuck which holds the work. When tools get this steadying support directly on or in the work, they are freed from the chattering due to the machine mounting, but not free from that due to their own frailty or to the intermittent flow of the chip as it is taken off in chunks.

Relative Destructive Effect of Heat and Lateral Vibration.

Attention should be called to the effect of heat in the destruction of the cutting edge, and no amount of care in the mounting of the work and tools will prevent destruction of the cutting edge of the tool by heat. Heat is undoubtedly most destructive when roughing at high speeds, but the vibration plays a very important, if not the greatest part in edge destruction when finishing at the usual speeds. As the speed is reduced, the vibration gains in relative importance, which should be taken into account in considering the no-clearance tool. With the slower speeds, tools should be used that give the best results at slow speeds.

The failure of the keen edge under normal cutting conditions, and its surprising endurance under some abnormal conditions, seemed to indicate great possibilities open to any scheme that would maintain the best conditions. For instance, the edge of a diamond point may be broken off by an

ordinarily heavy chip, at one time, and at another time a similar tool becomes deeply imbedded into the metal without breakage. Under some conditions a cutting tool will actually sharpen itself in the process of cutting, yet neither of these results is regularly maintained. They suggested, however, the possibility of supplying a means by which they could be maintained in regular work.

Clearance.

Since the birth of the slide rest lathe in which the tool was first guided by mechanism, turning tools have been given clearance and it has been assumed that they would not cut

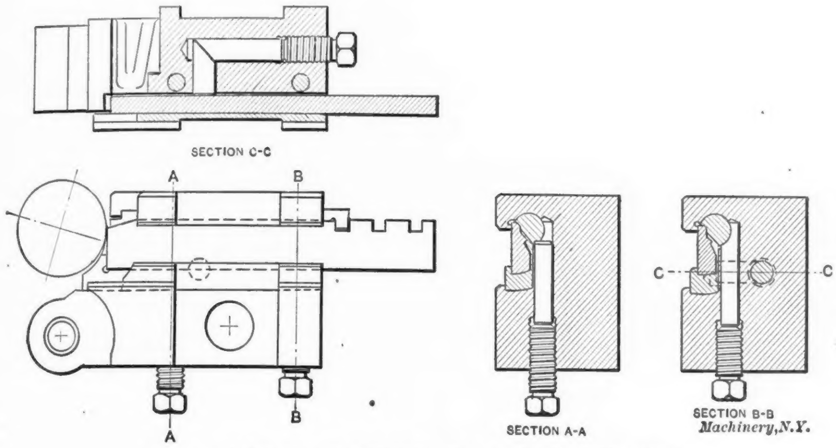


Fig. 8. Holder for No-clearance Tool in the Flat Turret Lathe.

without clearance. Of course, it is well known that the orthodox lathe tool goes out of commission after losing its clearance, but that does not demonstrate that a tool cannot cut without clearance. It only proves that the ordinary tools require clearance as they are now formed and mounted. A tool which has been ground for clearance and set in such a position that its under face is at an angle to the shoulder produced, presents but a small area to the shoulder of work when the clearance of the extreme edge has given way. The area is so small, compared with the stress of the abrading metal passing it, that it rapidly scores and wears into a rough surface standing at a negative clearance angle.

The tool which has been set by chance in an engine lathe, so that a comparatively large area of the under face rides on the wall of metal, does not wear away, because its surface is not subjected to as great abraiding pressure per unit of area. Its area is sufficient to withstand abrasion. It was therefore assumed that increasing the contact of the under face of the tool against the face of the work would make it possible to cut without clearance. The advantage of a no-clearance tool is that its face rides on a good area and supports the under edge against the pressure of the chip, thus relieving the edge from the one-sided pressure which must be borne by a tool having clearance.

No-clearance Tool.

In order to enable the tool to ride flatly against the wall of metal from which the chip is being removed, it must be mounted so as to allow a comparatively free swiveling action on a center line that is substantially coincident with the cutting edge of the tool. When the tool is so mounted, the pressure of the chip on the top slope tends to throw the so-called clearance face against the shoulder, for the mounting allows the tool to swing around to any angle that may be necessary to fit any work form, from a straight surface in planer work and the nearly straight surface in work of large diameter down to the angle of a helix obtained by the coarse feed on work of relatively small diameter. A tool so mounted either swings automatically to adapt itself to angularity of feed, or may be swung by hand as soon as the cut is started. Its natural tendency holds it snugly against the metal, but the force may be varied from one that equalizes the stress on each side of the cutting edge down to a very slight stress which only holds the tool in no-clearance position. An important feature is that the tool is free to swing around to offset the unequal wear on the "clearance" face.

The swivel mounting of the tool allows the cutter to swing around to take care of not only the feed, but the changing surface of the tool due to wearing action. In the early experiments, cutters were used which were clamped rigidly in a holder, which, in turn, was pivotally mounted on a fixed holder. The cutting edge of the tool was so located as to stand exactly on the center line of the swiveling holder.

In the later experiments the scheme has been simplified by loosely mounting the cutter itself, providing it with a round bottom struck from a center line which is near the cutting corner of the tool. The cutting edge is usually standing at an angle to its center line of swivel, giving the tool a front slope. The scheme of inclining the cutting edge to the line of swivel was adopted for the purpose of using a bar-shaped tool in which its shape could be maintained by grinding, for with this shape grinding back, the end provides for the wearing down of the top edge. This gives the tool a front slope when the swiveling center is kept horizontal. In some cases it may be well to tilt the holder to an angle that brings the cutting edge horizontal. This departure from the ideal center position of the line of swivel is not sufficient to cause any trouble. In fact, the pivotal line need not be exactly parallel to the cutting edge, neither is it necessary to have it very near the center line of swivel. It is probable that, under some conditions, the cutting edge may advantageously be located either

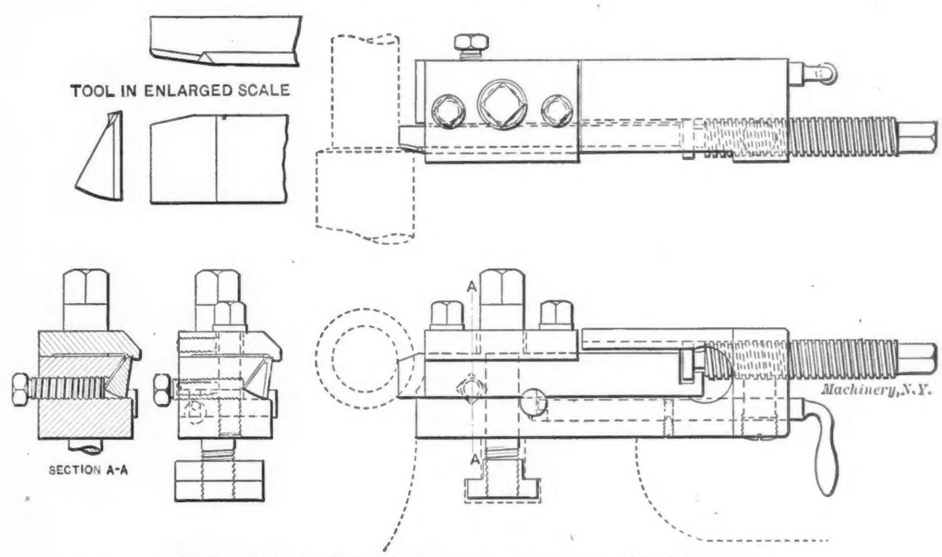


Fig. 9. Holder for No-clearance Tool when used in the Engine Lathe.

above or below or on either side of the cutting edge. The exact location of the cutting edge relative to the center of oscillation partly determines the pressure with which the tool rides against the wall of metal from which the chip is taken.

The extreme top edge of the tool, in some instances, has been slightly flatted on the more acute angles, the flat measuring from about one-sixty-fourth to one-thirty-second inch, and standing either 90 degrees from the so-called clearance face or sloping in either direction. Very good results were obtained by giving it a negative side slope of a maximum of from 10 to 15 degrees from the horizontal. This top flat seems to make a good resting place for the false edge, and it may be that its successful operation is dependent on the false edge.

One interesting phase of these experiments has been the

comparative willingness on the part of the tool to relieve the carriage of the duty of feeding. This first became apparent when the carriage continued to advance after the feed had been "thrown out." This self-feeding feature, of course, cannot apply to the action of planers, boring mills, or work of large diameter. It is only mentioned here to indicate the absence of resistance to the feeding motion under some conditions. The ultimate outcome of the use of acute angle tools may lead to allowing each tool taking a heavy cut on small diameters to determine its own feed. In the turret lathe this would be a distinct advantage.

Chip Lifter and Chip Control.

The chip produced by the acute angle tools possesses great lateral strength. The continuous chip is preferred by any operator who has had experience with hot chips which are

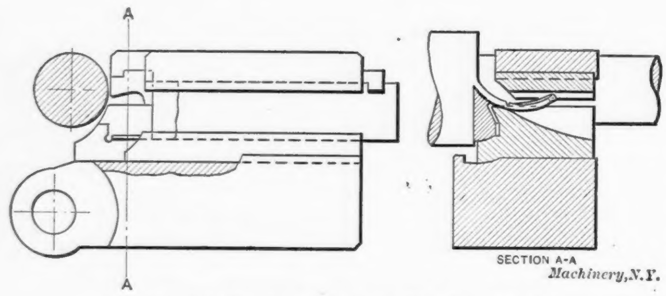


Fig. 10. Chip Breaker used in the Flat Turret Lathe.

thrown off by the tools of blunter angles, but while this particular feature enables him to closely observe the action of the tool without risk, the continuous chip in itself becomes troublesome, if allowed to run too long without breaking. In some of the first experiments with this tool, chips having a depth of about three-eighths of an inch, and produced by a feed of six revolutions of the work to the inch, were found exceedingly troublesome, especially when allowed to run out to lengths of five to fifteen feet.

The lateral stiffness of the chip of the more acute tool made it possible to increase the tearing open or splitting effect. In order to increase the tearing action of the chip it is necessary to allow the chip, after it has passed from the edge of the tool, to pass over a lifter in the form of a wedge, either formed integral with the tool or placed in the path of the chip near the tool, having an angle that not only assists in tearing the metal ahead of the tool, but will also relieve the slope of the tool near the edge from an important part of the work. Although this chip lifting effect may be produced by a top slope having a curved surface, it has seemed best for the convenience of grinding the tool on an ordinary wheel to keep the top slope of the cutter a flat surface, and introduce this chip lifter as a separate member, either as a part of the toolholder or in conjunction with the chip breaker described below.

Although it is a satisfaction to be able to stand near the cutting tool, and to know that the chips will not shoot out in hot chunks at all angles from the tool point, there remains the fact that a continuous chip is troublesome. Even with the blunt tools, the curling chips which are sometimes used to illustrate ideal working conditions of a machine, require constant attention of the operator, and either a very large receptacle which doubles the floor space required for the machine, or the almost constant attendance of an extra man for removing the chips from the room. The use of the more acute angles increases the chip trouble, and may in some instances make it advisable to retain the blunt cutting angles, or at least, tools which produce tolerable chips.

For turning bar work in the turret lathe it has seemed best to adopt a chip breaker which produces a fracture by placing an obstruction in the path of the chip at such an angle that the chip, shortly after it has left the tool, is bent beyond its breaking point either by lifting or depressing, or both. It is preferred to use a chip breaker which depends on depressing the chip after it passes over the chip-lifting incline. A breaker of this kind breaks the chip in lengths varying from one-half to three inches.

Conclusions.

The conclusions of the investigations may be summarized as follows: The no-clearance cutter relieves the edge from the one-sided pressure; it prolongs the life of the cutter by allowing abrasion on its face without producing negative clearance; it prevents lateral quivering; it converts the lip angle into cutting angle which for a tool of given form constitutes a gain of from 5 to 10 degrees in cutting angle; it has extended the working range of the side tool which gives the minimum separating stress; it has made possible the use of acute angle tools which reduce the cutting stress, thereby increasing the output of machines which have been limited by lack of pulling power; the reduction of the cutting and separating stresses has increased the accuracy on nearly all lathe work; this reduction also increases the output which has been limited mostly by the frailness or the slenderness of the work.

* * *

CUTTING WORMS AND HOBBING WORM-WHEEL SEGMENTS.

The two illustrations shown herewith explain the practice of the Garvin Machine Co. in making worms and worm-gear segments, such as are used for automobile steering gears. The cutting of the worm, as shown in Fig. 1, is done entirely by standard methods, the attachment shown in place in the machine being the regular spiral gear and worm milling attachment made by the builders. The use of an attachment of this kind permits the milling of spirals of very short lead, such as required for worms. It would not be possible to mill them with a cutter on the regular cutter arbor, as the table of the universal machine could not be swiveled to a great enough angle to permit this.

The hobbing of the worm segment requires special apparatus, the construction of which is plainly indicated in Fig. 2. The segment is mounted on an arbor with a worm-wheel of

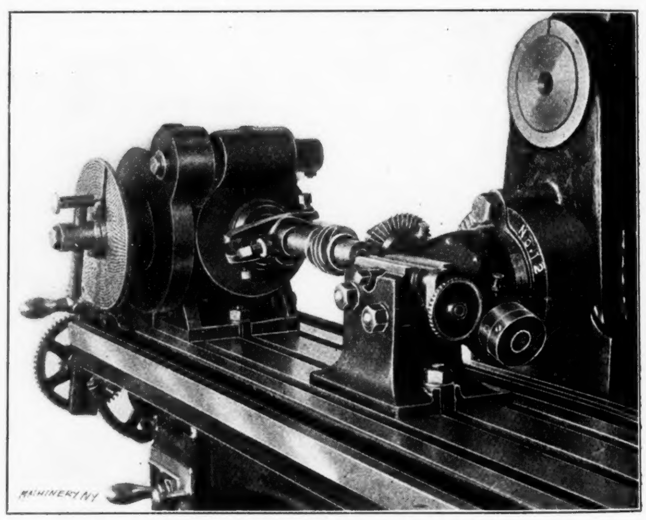


Fig. 1. Milling Worms with the Universal Attachment.

the same pitch and number of teeth as would be contained in the segment to be cut. On the cutter spindle is mounted a taper hob and a spur gear; the latter meshing with a corresponding gear of the same size, keyed to a worm supported in supplementary bearings fastened to the overhanging arm at the outer end, and to the machine columns at the inner end. This worm meshes with the worm-wheel on the arbor, on which is the work. This work arbor, with the worm-wheel and the work, is free to revolve when driven by the worm just described, being loosely mounted on the centers.

The principle of the hobbing operation is identical with that described in connection with Fig. 128, of the article entitled "Gear Cutting Machinery" in the June, 1908, issue of Machinery. The cutting operation starts with the saddle moved in toward the column until the work is beyond the hob at the small end, the knee being raised to the proper height so that the large or finished diameter of the hob will cut teeth of the desired depth. At this adjustment the driving worm and worm-wheel should be properly in mesh with each other. The saddle is fed outward, so that, with the ma-

chine in operation, the work is fed to successively larger diameters of the hob, which thus cuts deeper and deeper until finally the work passes out through the large end, as shown in the illustration. This finishes it to the proper depth. The work and the hob do not get out of step with each other, as the cross motion rolls the master worm-wheel on the master worm in just the proportion that the work should roll on the hob. Since the driving members do not get out of step with each other, the driven members do not.

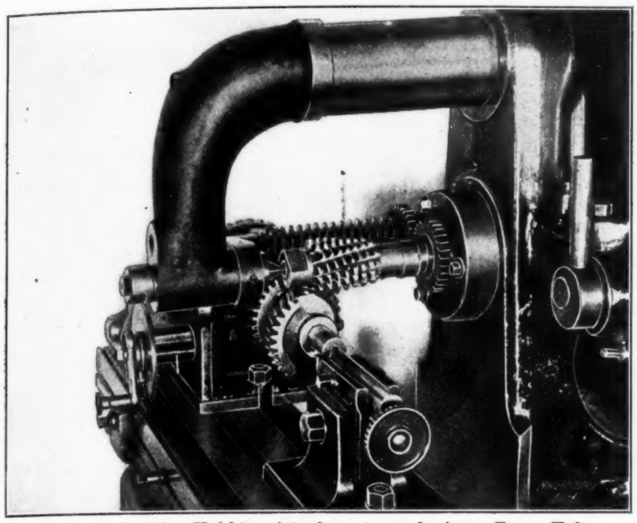


Fig. 2. A Positive Hobbing Attachment, employing a Taper Hob.

Of course the reason for making the worm-wheel in this way, aside from the question of time involved, is that the ordinary method of gashing and hobbing on a freely running arbor could not be employed in this segment worm-wheel. The apparatus would be fully as useful, however, with regular worm-wheels, doing the work in one operation instead of two.

* * *

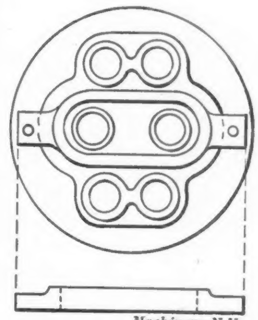
MACHINE SHOP PRACTICE.*

MACHINING INTERNAL COMBUSTION ENGINE DOUBLE-CYLINDER CASTING.

When castings, such as the one shown on the Shop Operation Sheet accompanying this issue, are to be machined, fixtures to facilitate setting the work are essential to economical production. If only one or two castings were needed, the extra time required for setting them for the different machining operations, without fixtures, would not be great enough to justify the expense of such equipment. We shall assume, however, that in this case a sufficient number of castings are to be machined to warrant such expenditure, and in the following a description of the fixture for holding these castings will be given, and the way the various parts to be machined are set in proper relation with the tools in the turret, explained.

It will be understood, of course, that the layout and construction of a fixture for holding work of the kind illustrated, will depend entirely upon the shape of the casting and location of the surfaces to be machined. The dot-and-dash lines in Fig. 2 represent a plan view of the casting shown on the Shop Operation Sheet. As will be seen, there are, in this particular case, four valve ports and the openings *V* and *X* to be machined on one end of the cylinder, and the two cylinders to be bored from the opposite end. If the fixture which is to hold the casting is to be efficient, it must be so constructed that the four valve ports and the openings *V* and *X* can be brought in line with the axis of the lathe spindle without resetting the casting, and also so that the cylinders may be bored with a minimum amount of trouble and the distance between their centers kept uniform. The fixture, which is shown in Fig. 2, consists of a base-plate *A*, and a cylindrical plate *B* having a boss which fits into a recess in *A*, upon which the plate revolves to change the position of the work. Obviously, if the casting is centered upon plate *B*, the four port openings may be made to coincide with the axis of the spindle by revolving *B*, if the base-plate *A* is properly located upon the face-plate of the turret lathe, and means provided for setting plate *B* so that the centers of the port openings coincide with the axis of the spindle.

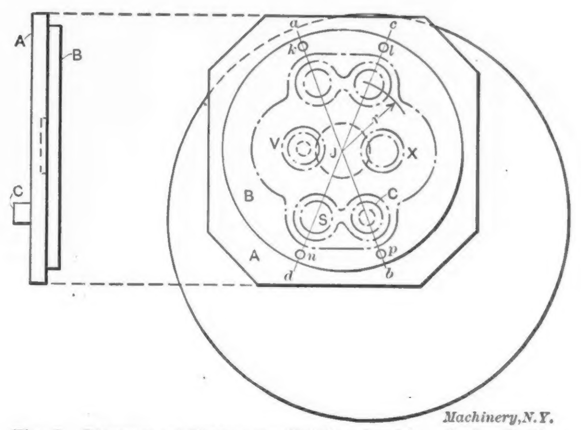
In laying out the base-plate *A*, the recess for the boss on plate *B*, and a hole for plug *C* which fits the hole in the spindle, are located upon a center line *a—b*, the distance between them being equal to radius *r*. After the boss on *B* has been fitted into the recess in *A*, the four dowel pin holes *k*, *l*, *n*, *p*, in plate *B*, should be located. The exact position of the centers of the four valve port holes are first laid out, and center lines drawn through them. Upon these lines and at points equi-distant from the center *J*, the four dowel-pin holes are drilled, and a hole to coincide with them is drilled in the base-plate *A* on center line *a—b*, at a point *k*. These holes are reamed with a taper reamer and a dowel pin fitted to them. It will be apparent that if the casting is centered on plate *B* so that the centers of the valve openings will come on the center lines *a—b* and *c—d*, each valve opening can be centered by revolving *B* and inserting a dowel pin in one of the four locating holes at a point *k*. For example if the valve seat *S* is to be machined, plate *B* would be revolved until dowel hole *l* coincided with the hole in base-plate *A* at *k*. The seat *S* would then be directly over locating pin *C* which fits into the hole in the lathe spindle.



Machinery,N.Y.

Fig. 1. Special Form of Clamp for the Fixture.

In order that the openings *V* and *X* be machined without resetting the casting, a second hole for the plug *C* is drilled and tapped in the base-plate *A* at a point corresponding with the center of *V*. When the four valve seats have been machined, straps similar to *Q* (see Shop Operation Sheet) are placed across the seats and *Q* removed, so that the holes *V* and *X* can be machined. The base-plate *A* is then removed from the face-plate, and the locating pin *C* shifted to the hole under opening *V*. When the base-plate *A* is again clamped to the face-plate, obviously, opening *V* will be centered. To center *X* it is only necessary to remove the dowel pin at *k* and turn plate *B* one-half a revolution. The removal of clamp



Machinery,N.Y.

Fig. 2. Diagram of Fixture for Holding Double-cylinder Casting.

Q and the substitution of others for this last machining operation, can be obviated by the use of the clamp illustrated in Fig. 1, which will not interfere with the movements of the tools and which will grip the work more firmly.

The next operation consists in boring the two cylinders. As the holes *V* and *X* are to be concentric with their respective cylinders, means must be provided for setting these holes true when the casting is inverted. As the work has remained in the same position with relation to plate *B*, this may be accomplished by locating two plugs, which fit the valve openings, at points on the center line *a—b* corresponding with the centers of the openings. When the position of the casting on plate *B* is then reversed, one cylinder will be in a position to bore and the other may be centered by revolving *B* one-half a revolution, using the dowel at a point *k* as before.

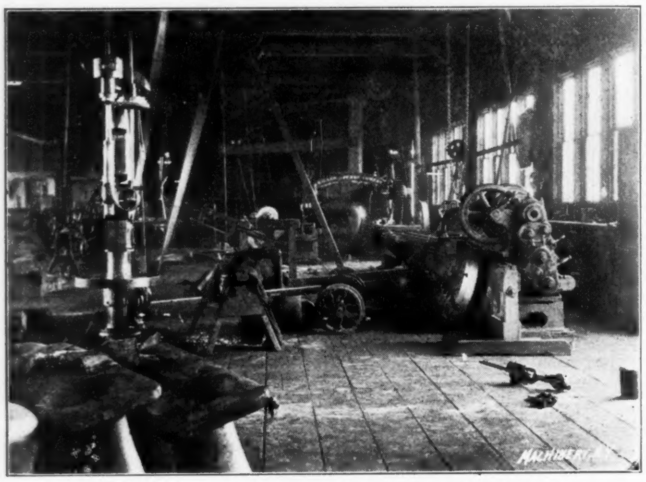
* With Shop Operation Sheet Supplement.

SHOP PHOTOGRAPHY.*

H. COLE ESTEP.†

It is the purpose of this article to give a few practical, pertinent hints on the taking of shop and engine-room photographs. If pictures are taken of ingenious hurry-up repairs, of the original appliances installed in the plant, or of new methods of setting up or handling work in the shop, supplemented by descriptive matter and drawings where necessary, it will be surprising to find how soon a complete, original, and valuable set of notes and data, which will be of constant service, can be collected. Furthermore, these data can be made useful to one's fellow craftsmen by publication in technical journals. Scale drawings and descriptive data are often essential, but usually, to get a clear understanding of an apparatus as it actually appears when in use, a photograph is indispensable.

The art of taking good photographs is not difficult, nor is expensive apparatus required. The writer has taken hundreds of pictures, which have been published in a score of technical magazines, all of which were made with a $20 folding hand camera. The prime requisites for a shop camera are flexibility and compactness. Pictures must be taken in all conditions of light and weather, indoors and out, for which an adaptable camera is necessary; odd angles, mazes of piping and cramped quarters require a compact construction. The lens for this work should have good definition



Photograph taken on a Film, thus Obviating the Halations Common to Interiors made on Plates.

(sharpness) and depth, should be reasonably, but need not be excessively, fast. The shutter should have a wide range of control and should work without jar. The bellows should be of such length as to permit the taking of small objects full size. The back of the camera, carrying the plate or film holder, should be reversible, so that it is not necessary to unscrew the camera from the tripod and turn it over, should a change from a horizontal to a vertical view be advisable. Ground glass is necessary for focusing, and, as will be seen later, a good, accurate view finder is often useful. Contrary to the experience of some, I have found the 4 x 5-inch size to be the most suitable; enlargements can be made, if necessary. This size combines features of economy of operation with a light and compact apparatus. I therefore use a 4 x 5-inch folding plate camera, the box, when closed, measuring 6 x 6 x 3 inches. This apparatus has a bellows, which can be extended to 13 inches, a good double rectilinear lens, giving sharp pictures with a wide open diaphragm, an automatic shutter working from 1/100 to 1 second, a reversible back, and ground glass focusing screen. The camera complete with case and one plate-holder cost $20. I discarded a roll film kodak, because it would not permit focusing subjects on ground glass; this focusing must always be done when possible, if uniformly accurate results are desired.

At an expense of $1.50 I produced a "film-pack adapter," enabling me to use daylight-loading film-packs, thus combining all the advantages of the plate and roll film cameras, with none of the drawbacks of either. I have used film-packs for two seasons, and find them admirably suited to shop picture making. Using films, I have often taken pictures directly against the strong light from adjacent windows, without the slightest blur, or any of the evil effects of halation, inevitable with plates. An example of this is shown in the accompanying half-tone, where a good picture is presented in spite of the poor light of the shop.

After selecting the proper apparatus, the next thing, in order to secure good results, is the proper lighting of the subject. The over-zealous amateur often reasons, to his subsequent undoing, that since light makes the picture, one cannot have too much of it, forgetting that it is the contrast of light and shadow and the shading of light into shadow that really makes a good photograph. Unfortunately, the matter of lighting in work of this kind is usually absolutely beyond the control of the operator. About all he can do is to select the point of view best suited to the subject and take the light as it comes. Reflectors and screens are used by some, and although they are of service, my experience has been that they are usually more bother than good. Wherever possible, the light should be from the side, striking the floor at an angle of 45 degrees from the horizontal. But these are "laboratory" conditions with which we are not concerned. Machinery, lathes, etc., that are not too large, can be set in relief by a white background. In taking pictures in boiler rooms, I have often made pipes, practically invisible at first, stand out by an application of whitewash or whitelead.

Much of the evil in shop photographs, due to the unavoidably poor lighting, can be ameliorated by proper exposure. As in all kinds of picture taking, accurate exposure is the key to success in shop photographs. The question of exposure brings with it the one of diaphragm or stops. The lens of the camera is supplied with an iris diaphragm, by means of which the hole through which the light enters can be varied in diameter from about 1/16 inch to the full diameter of the lens. Except where extreme sharpness is required, I have found that a U. S. No. 16 stop (diameter ¼ inch) is the best lens opening for all around work. The question of proper exposure is one of experience entirely, by the aid of which one feels what is right without going through any definite reasoning process. However, as a guide, I have established what I call "a standard exposure under standard conditions, using a No. 16 stop." It is defined as follows: With clear weather outside, the standard exposure, using films, in the interior of the *average* shop or engine room is 35 to 40 seconds. In hazy weather, double this time; in dull, cloudy weather, quadruple it.

Often one cannot focus on the ground glass and must depend upon the scale of distances on his camera-bed for focusing, and upon his view-finder for properly placing the subject. A very little practice will enable one to judge distances accurately and focus with the scale. The view-finder should be tested by focusing some object on the ground glass and observing its position in the finder. It is rare that an object in the center of the plate will also appear in the center of the finder. The error must be determined and allowed for when using the finder alone. Use a light, stiff tripod and do not straddle one leg while focusing. A gossamer focusing cloth is best. At a small extra expense, a supplementary wide-angle lens can be obtained, which will be found very useful in tight corners.

Unless one is experienced, it is best to have the developing done by an expert. To obtain the best results in this class of work, the negatives should be printed on glossy silver-chloride paper, toned to a deep brown, almost verging on a blue, and giving a high polish in a burnisher or on a ferrotype plate.

* * *

The State Department announced some time ago, officially, that the World's Fair, which was to have been held at Tokio, Japan, in 1912, has been postponed by the Japanese until 1917, when it is proposed to have a grand celebration in commemoration of the fiftieth anniversary of the Mikado's ascension to the throne.

* For additional information on this subject, see the following articles previously published in MACHINERY: Correcting Perspective in Shop Photography, February, 1908, and other articles there referred to.

† Address: 302 Pioneer Building, Seattle, Washington.

LARGE COLLET MADE ON AUTOMATIC SCREW MACHINE.

In the November issue of MACHINERY some interesting work produced on a large sized Cleveland automatic screw machine, manufactured by the Cleveland Automatic Machine Co., Cleveland, O., was illustrated. This work consisted of a cast iron piston provided with a stem, practically finished all over, and a drill chuck with taper shank. The size of the parts made, and the rapidity with which the operations were performed, gave special interest to this article and illustrated in a clear manner how the automatic screw machine has during the last few years proved itself capable of performing a great many operations, which but a short time ago were considered as belonging to the province of the engine lathe. In the half-tone accompanying the present article is illustrated a piece of work the dimensions of which are larger than those of the parts shown in the previous issue. The work illustrated is a collet used in the Cleveland automatic screw machine, made from 40 points carbon steel; it is made from the bar in one hour and ten minutes. The full significance of this will be better appreciated by referring to the dimensions of the collet as shown in the line-engraving, Fig. 5. It will be seen that the largest diameter of the collet is 4⅝ inches and that the length is 7 1/16 inches. The size of the bar, as indicated in Fig. 2, is the same as the largest diameter of the collet when finished.

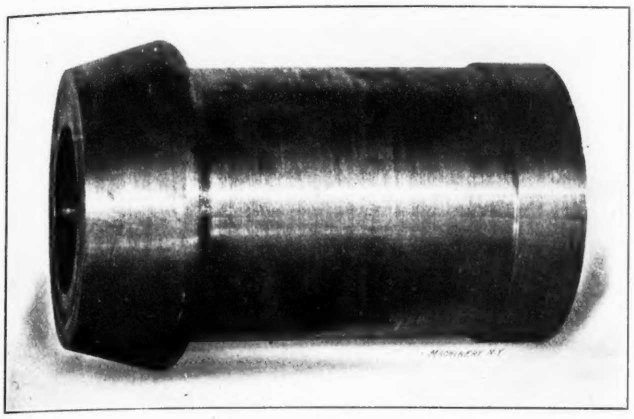


Fig. 1. Collet, 4 5-8 Inches in Diameter, finished from 40-point Carbon Steel in 70 Minutes on an Automatic Screw Machine.

The operations performed on the bar are shown in the four line-engravings, Figs. 2 to 5. In Fig. 2 the bar is shown fed forward to the proper position and centered. In the second operation the small hole through the bar is drilled as shown in Fig. 3 and the outside of the collet is formed by a forming tool as indicated, the whole length of the cylindrical surface of the collet being formed at once. The diameter of the hole drilled is 2¼ inches. In the third operation this hole is counterbored to a diameter of 3⅝ inches and to a depth of 5 inches, as shown in Fig. 4. Finally, in the fourth and last operation, this counterbored hole is reamed to the exact size and the collet is cut off from the bar.

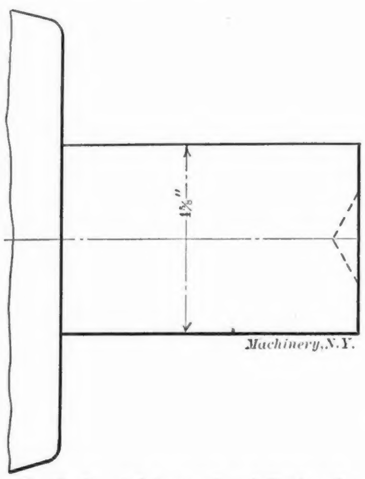


Fig. 2. Bar fed forward and Centered.

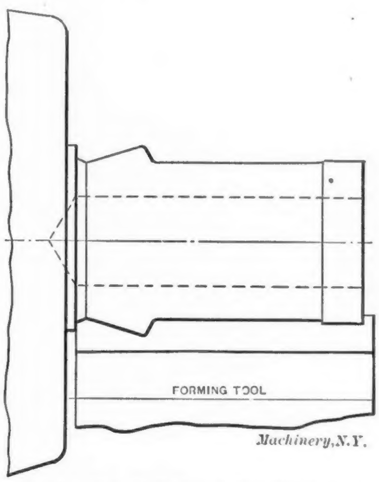


Fig. 3. Hole drilled and Outside formed.

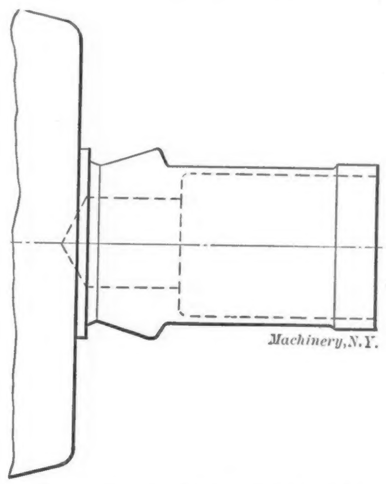


Fig. 4. Hole in Collet counterbored.

The weight of the stock from which this collet is made is 34½ pounds before machining, and the weight of the collet when finished and cut off is 8½ pounds. It will thus be seen that the stock removed in seventy minutes is 26 pounds and that the metal has been removed at the rate of nearly 0.4 pound per minute. Taking into consideration the expense of producing this piece of work, it will be noted that inasmuch as the operating expense of the automatic screw machine employed is only a mill a minute, the actual labor cost for this collet chuck blank is only seven cents. The same piece could be produced from machine steel of about 10 or 15 points carbon in about fifty minutes, or at an actual labor cost of about five cents, which is a remarkable performance if compared with the time required to perform this work either in a lathe or in a hand-operated turret machine. It is not only the size of the work in this case which is of interest to the mechanic, but also the accuracy with which it is performed. Thus the front end of the collet is provided with the correct taper required, when it leaves the screw machine, and the outside diameters are of correct dimensions. The forming operation employing but one single forming tool for a surface over seven inches long and of a shape requiring considerable more metal to be removed at some places than at others, is also very remarkable. In the past it has usually been considered impossible, or at least impracticable, to attempt to take forming cuts of such width; and the present example gives one an entirely different idea of the possibilities of forming operations with forming tools of broad face, than has been generally entertained by mechanics.

The size of the machine in which the work illustrated was performed is, of course, of large dimensions, it being known as a 6-inch automatic, and handling bars weighing from one thousand to twelve hundred pounds. There are, doubtless, many mechanics working in shops where small and medium-sized work is being done, who will be surprised to learn that such large automatic screw machines are being built, which are capable of producing work of the size here illustrated.

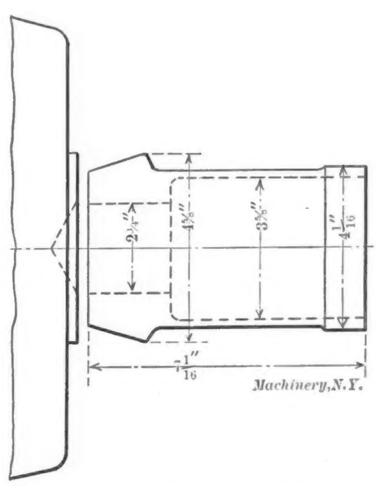


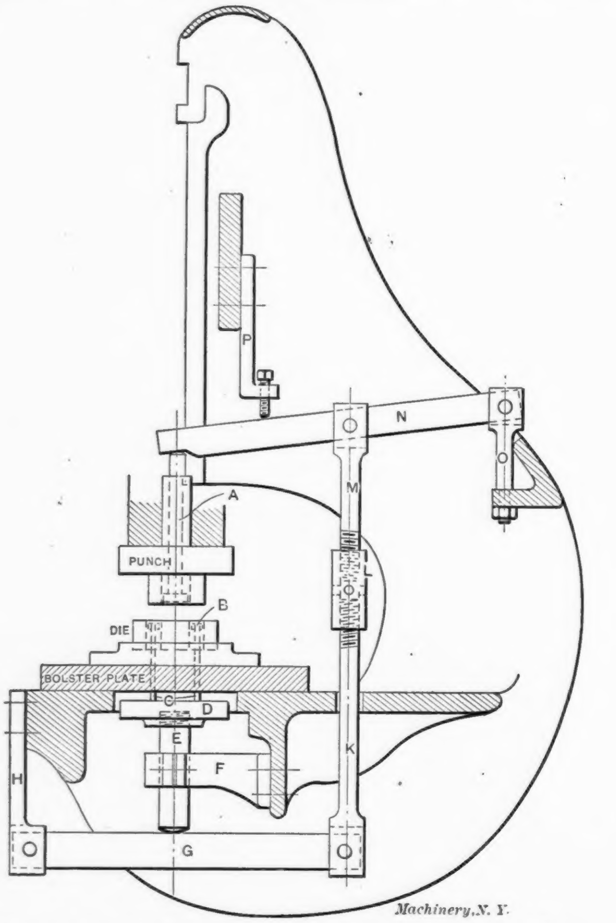
Fig. 5. Collet cut off, after Counterbore is Reamed.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

STRIPPER ATTACHMENT FOR PUNCH PRESS.

It happens frequently in a great many shops that the punch presses do not give half the results they are intended to give; for example, the inclinable presses are not used inclined, and the tools put on them are provided with the "spring and rubber" type of stripper, with all the annoyances belonging to this type, *viz.*, only one-half of the stripper working, the springs breaking, the dies split by the rubber, etc. In a shop within the writer's experience, where these conditions prevailed, it was finally decided to design a stripping arrange-



View showing the Way in which the Stripper is attached to a Press.

ment that would work right, and the device shown in the line engraving was installed. The illustration shows a section through the inclinable part of the press and indicates the position of the ribs. The tool shown is of the washer type, *i. e.*, the punch is a ring, cutting both on the outside and inside. Inside of the punch is fitted a stripper plunger *A*. This plunger is longer than the punch, so that its end extends beyond the shank of this tool.

The die has a circular stripper *B* to which are attached rods *C* descending under the bolster plate. The ends of these rods bear on a circular plate *D* supported by a shank *E*. This shank moves freely through the bracket *F* bolted to the press frame. The lower end of shank *E* rests on a lever *G* held in a support *H* fixed in the front of the table of the press. At the other end, this lever is attached by rods *K* and *M* to the lever *N* which bears on one end on the top of the stripper plunger *A* and is pivoted at the other in a support *O* fixed on a cross rib of the machine. The combined length of rods *K* and *M* is regulated by the turnbuckle *L*.

This attachment works as follows: Let us suppose the press ram is in the lower position, the tool cutting the blank. As the whole stripping device is supported from plunger *A*, all parts are in the lowest position. When the ram starts upward the weight of all the moving parts of the stripper is supported by the blank in the punch, this being generally enough to strip the punching. The plunger *A* is prevented from coming too low down by a collar, not shown. Going higher up, the press ram carries along, through the levers, the plate *D*, thereby stripping the lower blank. If the upper blank did not give way at first, it is stripped when the lever *N* encounters the stop *P*, the lower punching being then already stripped.

In making such an arrangement, one should not be afraid of putting too much strength into it. We had Bliss No. 21 presses, that is, presses with about 8 inches opening and a crank-shaft 3 inches in diameter, and we used 3 × ¾-inch machine steel for lever *N*, 4 × ¾-inch for lever *G*, the rods *K* and *M* being 1 inch. All the small pins were ¾ inch, and the guide *E* 1½ inch in diameter.

New York. E. FULBER.

RELIEVING SPECIAL REAMERS.

In making many forms of special drills and reamers, used in valve work or for other irregular forms, the relieving attachments usually furnished with the Pratt & Whitney or Hendey-Norton lathes, will not cut all angles of relief. This necessitates hand work where it is least desirable, as inaccuracy will cause chattering or rough and oversized holes. For the class of finishing reamers shown in Fig. 1, relief at *B* is

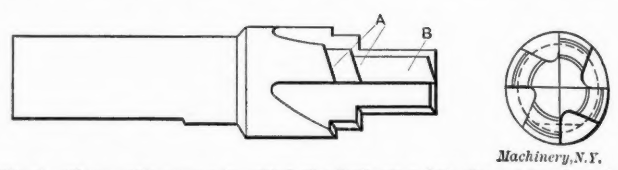


Fig. 1. Class of Reamers to which the Relieving Attachment is adapted.

easily cut with the standard relieving attachments, but relief at points designated by *A* is not so easily obtained, especially if it is desired to undercut the corner slightly.

Not long ago, in a shop where thousands of special reamer and drill forms are turned out each year, I saw an attachment made to use in conjunction with the regular relieving mechanism, that enabled the tool-maker to cut relief at any

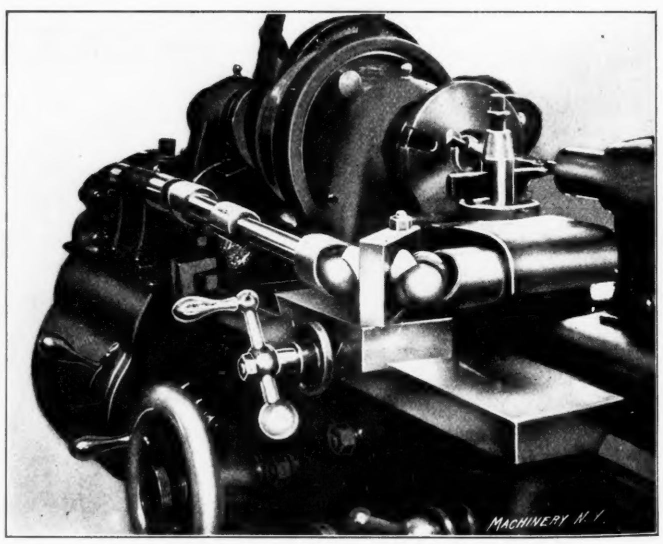


Fig. 2. The Relieving Attachment in Place on a Lathe.

desired angle, with as much ease and certainty of accurate results as in relieving plain work in the regular way. This attachment is shown applied to a Hendey-Norton lathe, in Fig. 2. It consists, primarily, of an additional universal joint mounted on a sliding base or carriage of its own. This double joint taking the place of the regular single joint, allows the compound rest or tool carrriage to be operated at any angle within an arc of 90 degrees, or even more if needed. The usefulness of this attachment will be apparent, at once, to anyone having use for a relieving mechanism. It was designed by a local tool-maker, and all the parts made by him, except the universal ball joints which were made by the

Hendey Machine Co. The device has been in use about two years, and has given satisfaction on all classes of work.

Referring to Figs. 2 and 3, the base of the device *A* is made a nice sliding fit in the cross-slide ways, and is left free to move out or in with the tool-post mechanism. The upright part *B*, which carries the two universal ball joints, is clamped at any desired angle by means of the bolt *E* which engages a nut sliding in the slot *C*. As the motion of the cam shaft and universal joints is oscillating, the bearing in the upright part *B* is simply a bored hole with a well-fitted pin inserted in it to hold the two ball joints together. The rod *F* is the

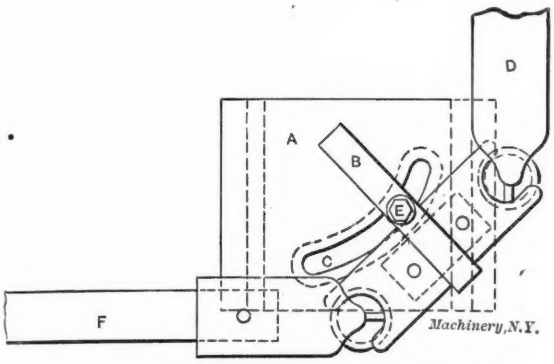


Fig. 3. Plan of the Attachment showing its Construction.

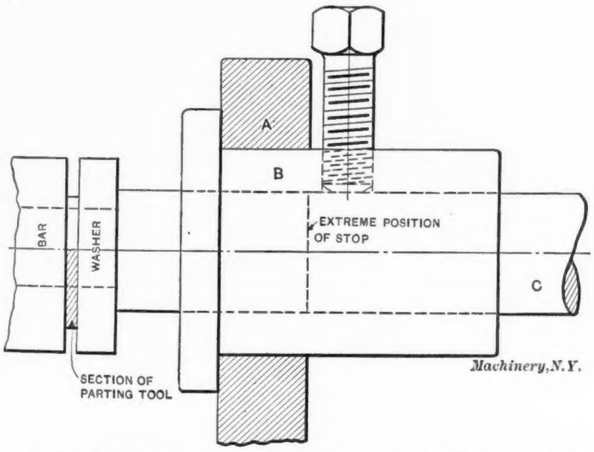
regular cam shaft connecting with the cam and gearing at the left of the lathe, while part *D* connects with the tool-post mechanism.

The beauty of the device lies in its simplicity and the ease with which it is placed on the lathe and set at the desired angle. It is also useful for relieving many forms of special and irregular, formed milling cutters, and it is the only device that I know of that enables one to relieve the cutting edges on the *inside* of the hollow mills or "outside reamers," that are so convenient for sizing various parts used in brass valve work, but which are not usually used on account of the difficulty of obtaining accurate inside relief. Everyone knows that relief is absolutely necessary for tools of all kinds, used for brass cutting, especially the brass usually used in a manufacturing plant. ETHAN VIALL.

Decatur, Ill.

STOP FOR JONES & LAMSON TURRET LATHE.

The accompanying engraving shows a stop for work up to, say, six inches long, to be used in the Jones & Lamson turret lathe, in place of the regular swinging stop. When the latter is used, it is necessary to run the turret slide of the machine back against a stop fixed at a predetermined point on the bed. This consumes a certain amount of time. When



New Form of Stock Stop for Jones & Lamson Turret Lathe.

turning up bushings, washers, etc., which are cut off from the bar, a stop such as illustrated will be found advantageous on account of its convenience. The sectioned part *A* is that part of the regular cross-slide through which the bar ordinarily passes when cut off, and which is provided with a hole for the bar. In this hole the bushing *B* is inserted, which, in turn, holds the stop rod *C*. This stop rod can be pulled back inside of the bushing, as indicated by the dotted line in the engraving, leaving only a sufficient amount for the binding screw to bind against. When the work is comparatively short it can be passed up against this stop, and cut off to proper dimensions, without making use of the regular swinging stop provided. It is clear that the longest length of stock that can be gaged in this manner is determined by the location of the cutting-off tool in relation to the location marked as the extreme position of the stop in the engraving. FRANK L. IMMER.

Pilot Knob, Mo.

MACHINING PLANE SURFACES TRUE WITH BORED HOLES.

When small castings, etc., are to be bored in a lathe, so that the hole will be true with another surface, a very quick and accurate method of doing this is as follows: Bolt the piece to the face-plate in such a manner that the hole can be bored first; then take the face-plate off the lathe without disturbing the setting, and clamp it to a milling machine or planer table, and machine the surface, using the edge of plate to measure for center distance. Recently I had two castings (see Fig. 1) to bore and finish on the bottom. The center distance *A* had to be about right, and the holes in line with the bottom. I proceeded by clamping both castings

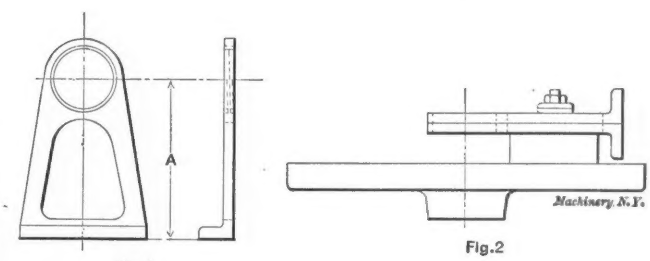


Fig.1 Fig.2

Figs. 1 and 2. Work to be Machined and Method of fastening to Face-plate so as to bore and mill at one Setting.

on the face-plate, as shown in Fig. 2, and boring and threading the holes, after which I took the plate off the lathe, and clamped it to the milling machine table. By measuring the diameter of the face-plate and subtracting the center distance *A* from the radius I obtained the right distance to feed in after touching the edge of the plate with the end mill. This was a very quick and accurate way of doing the job. It will be understood that the outside diameter and back edge of the face-plate must be true when on the lathe spindle.

Providence, R. I. R. C. SCHOLZ.

SOME USES FOR WROUGHT IRON PIPE.

Wrought iron pipe may be used to such good advantage in many emergencies that it is only necessary to show a few examples to prove how widely useful its application may be. In cutting round holes in brickwork, masonry, or concrete, it has become quite common practice to discard the old star chisel, and use instead the common form of the so-called "brick drill," which is nothing more or less than a piece of pipe with teeth filed across one end similar to saw teeth. Repeated case-hardening in prussiate of potash gives sufficient hardness to penetrate even the most stubborn concrete walls. To provide slight clearance for the body of the drill as it enters into a deep hole, the teeth should be mushroomed out slightly with a round taper plug. To avoid splitting the pipe by the repeated blows of the hammer, a malleable iron cap should be screwed tightly to the end, thus furnishing a good head for striking blows. Chips do not retard the cutting action of this form of drill, because they crowd down into the hollow core, and are removed when the drill is withdrawn from the hole.

An extension for a 5/16-inch twist drill can easily be made of a piece of ⅛-inch pipe of suitable length, by tapping out the hole in one end with a standard 5/16-inch tap and running a die over the shank of the drill for a distance of about ⅜ inch. When pipe and drill are thus screwed together, the drilling operation has the tendency of making it hold tighter in the extension, but if the drill should hap-

pen to break before the seam in the pipe splits open it is an easy matter to replace the broken shank with a new drill. We hear so much about positive-drive drill chucks, double-tang drills, oval sockets, etc., that I wonder why we do not drive all drills by means of a standard thread on the shank the same as a lathe chuck. If the only objection is the added cost of the thread, it seems as though we might have quite an interesting discussion on all the merits and demerits of the various positive-drill drives. On some of the larger sizes of drills the standard pipe may not be strong enough to stand the pressure of driving the drill after being tapped out; the end may then be covered with a reducing coupling and then tapped out, or better still, extra strong or double extra strong pipe may be used if it is on hand.

When cutting off heavy stock in the circular cutting-off saw or in the hack-saw, it is advisable to support both the overhanging ends. A cheap and serviceable stand having no loose parts and able to stand hard usage may be made as follows: A standard cast iron flange 8 inches in diameter, tapped for ¾-inch pipe, is used as the base. An upright piece of the right length is screwed into the base, and to the upper end is fastened the support upon which the bar rests. This support consists of a tee having two elbows screwed up close into the ends by means of close nipples. When all is tightly screwed together, the top of the tee should be the same height from the floor as the bed of the saw. Two or more of these stands at each saw do away entirely with blocking up, prevent heavy bars from crashing into the floor, and enable one man to cut with safety any bar he is able to lift. H. J. Bachmann.

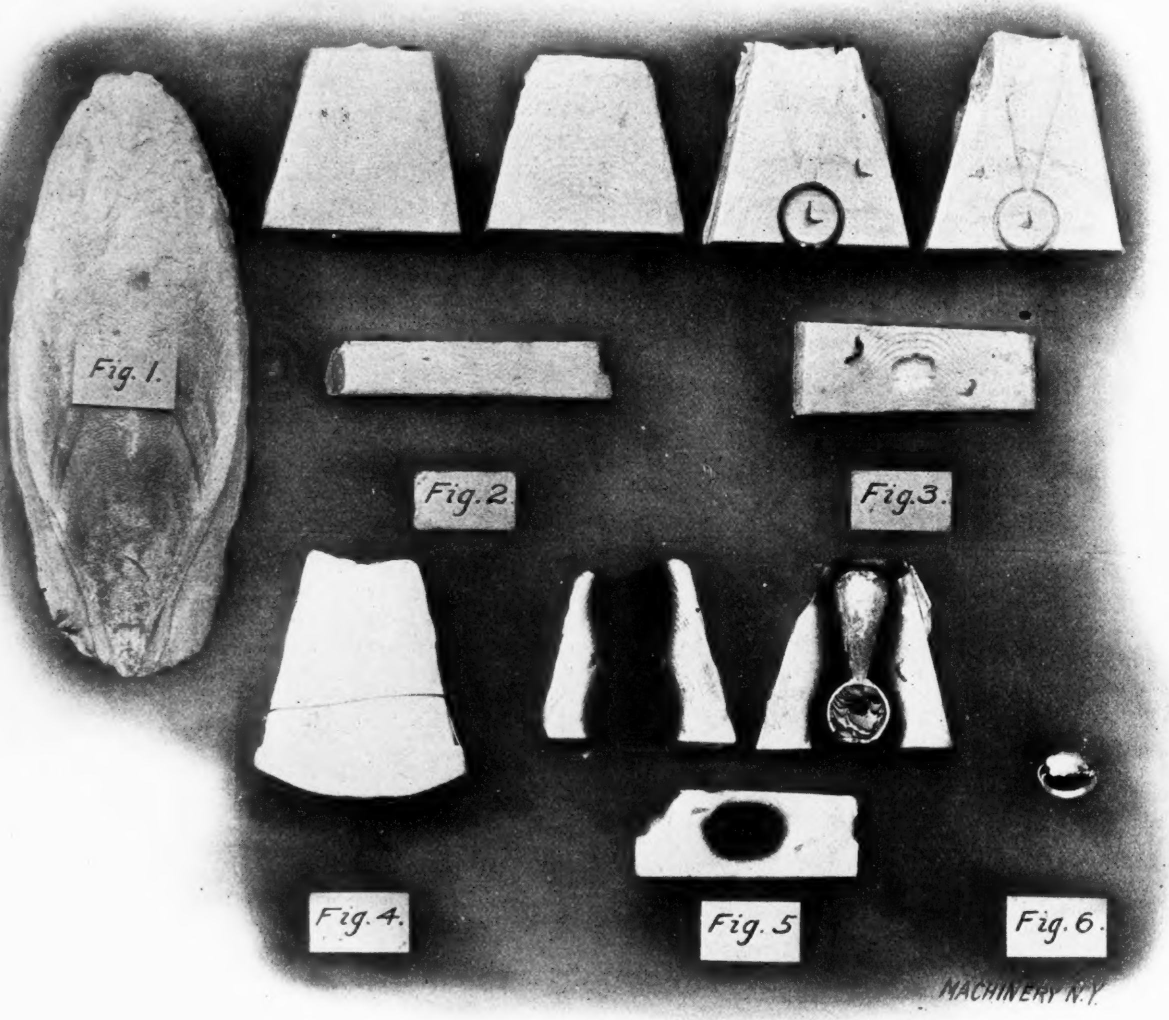
New York City.

[The light weight relative to its strength, and comparative cheapness of pipe, has made it a very valuable material in many constructions in the shop. The common usage for bannisters, railings, etc., is well known. Adjustable stands for electric lights are often made from gas-pipe, and we have seen the frames of plumbers' work benches built up entirely from pipe fittings. For many of these purposes discarded pipe is as good as new, and, of course, very much cheaper.—Editor.]

INTERESTING MOLDS FOR FINGER RINGS.

The accompanying half-tone engraving illustrates a phase of metal working which no doubt will interest men who are used to working in the cruder materials, but unfamiliar with the handling of precious metals. The illustrations show molds for casting finger rings, as used by jewelers. The material of which the molds are made is simply cuttle-bone.

Fig. 1 shows the rough bone in its familiar form, while Fig. 2 shows three parts of a mold ready to receive the impressions of the pattern. It is in the matter of making the impressions that one of the most valuable properties of the cuttle-bone is exhibited. A metal pattern slightly larger than the ring is to be, is employed. This pattern is simply placed between the parts of the mold shown in Fig. 2, and the parts are pressed together, the cellular structure of the bone permitting the pattern to indent the surface, producing a mold as shown in Fig. 3, where the pattern is still embedded in one part of the bone. It will be noted that the "seal" part of the ring is formed in the lower piece of bone, and the circular portions in the two upper halves. The pattern is now "drawn," and the gate cut as indicated. The mold is then wired together, as shown in Fig. 4, the alignment being preserved by the V-shaped metal pieces indicated in Fig. 3, which are pressed into the bone at the same time as the impression of the pattern is taken. The molten metal is



Cuttle-bone, and Molds which are made from it for Casting Finger Rings.

now poured; the effect of the heat is shown in the coloring of the bone, in Fig. 5. In one part of the mold in Fig. 5, the ring is shown in place after casting, with the sprue attached, and the completed ring is shown in Fig. 6. After casting, the rings are filed and engraved.

Some rings are cast in sand molds and some in metal molds, but cuttle-bone makes a very simple mold and does not require any venting, on account of its porosity. The writer is indebted to Mr. M. Lichtenstein, of 19 South 48th Avenue, Chicago, for the set of molds from which these photographs are taken.

Chicago, Ill. W. E. Morey.

UNIQUE TURRET LATHE TOOL.

It is required to finish a number of castings, as shown in Fig. 1. These castings are 10¼ inches in diameter, and provided with steps or recesses as shown. The castings are to be finished all over, and as turret lathes have only six holes in the turret for tools, the question presents itself how to finish the stepped face in one operation, if possible. The tool shown

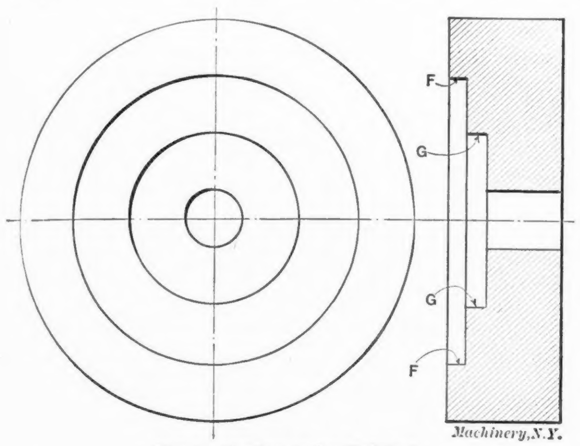


Fig. 1. Casting to be Finished.

in Fig. 2 was constructed for this purpose, and is used in connection with the guide C in Fig. 3. The cutter shown in detail at D, Fig. 2, is made of high-speed steel, and the guide C of machine steel and case-hardened on the faces B. When machining the casting, two boring-bars are used, one for rough boring and the other for finishing the hole preparatory

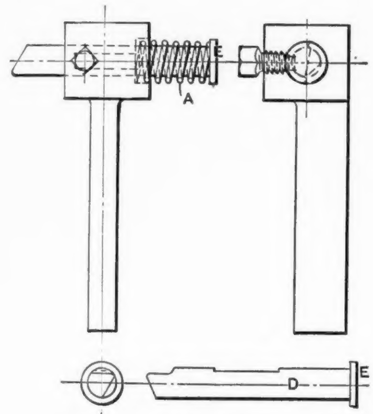


Fig. 2. Tool held in Tool-post on Cross-slide in Turret Lathe, for Finishing Casting in Fig. 1.

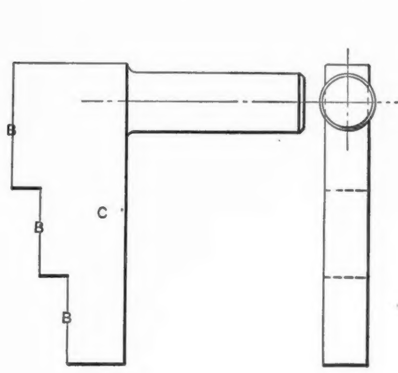


Fig. 3. Guide for Turning Recess in Casting, Fig. 1, used in Combination with Tool in Fig. 2.

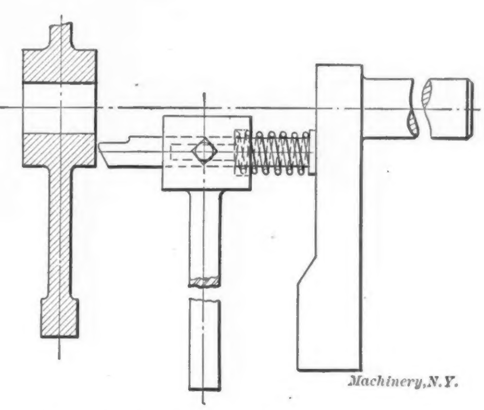


Fig. 4. Facing Hub and Rim of a Gear Blank by the Tools shown in Figs. 2 and 3.

to reaming. These tools, together with the reamer, occupy three holes in the turret. In the fourth hole is inserted the stem of the stop C against which the end E of the cutter D rests when taking the cut. The holder for the cutter is held in the tool-post on the cross slide, and when the guide C is brought up against the end of the cutter, the spring A is compressed. The deepest recess of the work is now finished. It will be seen that as the end E of the cutter D moves outward on the guide C it will reach the first step, and, actuated by the spring, will slide down this step and finish the intermediate recess in the work. It then slides down to the lowest step on the guide, finishing the outside face or side of the work. The fifth and sixth holes in the turret are used for holding flat cutters for finishing the surfaces F and G, at the same time removing the rounded corner between the steps which is caused by the previous operation. In Fig. 4 is shown a gear blank faced on the hub and rim with the same tool in combination with a corresponding guide. The illustration shows plainly the manner of operation. This tool is particularly commendable in cases where the turret has not enough holes to receive all the tools required if a separate tool were provided for each surface. To be able to turn two surfaces by the same tool is therefore very essential in many cases, and is made possible by the tool construction shown.

Lowell, Mass. J. S. Scott.

RAPID STEEL ARMOR PLATE PLANING.

Some good planing was recently done in the shops of the Witkowitzer Bergbau und Eisenhütten Gewerkschaft. The piece was a hardened steel armor plate of Krupp's best make, 5.81 inches thick. In three hours and fifteen minutes, without re-sharpening the tool, there were removed 115.94 cubic inches of steel. The cutting speed was 16.76 feet per minute; the feed 0.12 inch; and the depth of cut 0.512 inch. The establishment mentioned, reports that this is the best work in this line yet done therein. It was, of course, performed by one of the numerous rapid-cutting steels which have sprung up all over Europe after the introduction of the Taylor-White process in 1900. G.

THE ACKNOWLEDGMENT OF ADVERTISING MATTER.

As you are doubtless interested in anything contributing to the efficiency of trade paper advertising, we take the liberty of suggesting a matter that is often brought to our attention by clients.

Advertising in the trade and technical papers brings inquiries of various sorts, some from people who are interested in the purchase of apparatus, others from persons who wish to inform themselves about the subject in question, and still others from people who appear to apply merely through curiosity, or the desire to get something for nothing. Now, the majority of manufacturers, while they often spend considerable money in the preparation and printing of their catalogues and other trade literature (the bare cost of printing alone often running up to 50 cents or 60 cents per volume), do not, as a rule, object to filling the requests of all three classes.

However, the publication of advertising literature is only one step in the selling campaign, and once the prospect has been opened, the organization of selling forces is such that other steps should follow, as it were, automatically. The next thing, therefore, for the salesman to do after receiving an inquiry and sending the literature requested, is to call upon or write to the inquirer to find out what his needs may be. This frequently leads to much waste of time and money. The man who asks for a catalogue may not, as suggested above, be in the market, and if he is located in some out-of-the-way place, it costs a good deal to find this out by means of a personal call.

The point that we wish to bring out is that people who ask for catalogues should at least acknowledge receipt of the

printed matter, and of the letter which usually accompanies it, stating whether or not they expect to purchase in the near future. They rarely ever do this, thereby putting not only the manufacturer, but often themselves also, to some inconvenience and annoyance, inasmuch as the manufacturer has gone to the expense of printing this matter and of mailing it, a simple acknowledgment would seem to be in order, especially as many manufacturers now enclose return postal cards, oftentimes stamped, for this very purpose.

If you could consistently take this matter up in your reading columns and say something which would lead to a more general understanding of the situation on the part of the public, we believe it would lead not only to a lessening of the expense and labor involved in selling machinery, but also to the higher efficiency of trade and technical paper advertising.

New York. THE GEO. H. GIBSON CO.

SIMPLE WIRE-BENDING TOOL.

The accompanying half-tone engravings illustrate a piece bent from plain steel wire, and the appliance used in performing the various bending operations. The straight wire shown in Fig. 1 is 8 inches long, No. 6 gage. The shape of the wire after it has passed through the consecutive operations, is plainly indicated in the same illustration. Fig. 2 shows the appliance for performing the work, which is here shown in the position where the straight wire is placed in the opening between the jaws *A* and *C*. The inside former or jaw, *A*, is bolted to the bottom plate *B*, while the outside former slides back and forth on the pins *K*. A spring between the two jaws keeps them apart when the levers are in the position in Fig. 2. The two pins *K* also support the wire when placed in the tool by the left hand of the operator, and a small pin located at *Y*, in the sliding jaw *C*, acts as a stop for laying the wire at its proper place for bending. The lever *D* is now swung around by the right hand of the operator, to the position shown in Fig. 3. This brings the jaws together and produces the first bend. The part of the wire, which extends beyond the jaws, is now in position for the second bend. The operator takes hold of lever *E* with his left hand, and swings this lever downward against the fixed jaw *A*, making a second bend, as shown in Fig. 4. The operator now removes his right hand from lever *D*, and grasping the lever *F*, produces the third or last bend, as shown in Fig. 5. The latch on hook *G* holds the two jaws together after lever *D* is released, as shown quite plainly in Fig. 5. The direction of motion of lever *F* is now reversed. The end of the latch or hook *G* is beveled, so that when lever *F* is swung back, the hook is raised and disengaged from the jaw, thereby permitting the jaws to open. At the same time, springs, not visible in the illustrations, act on the levers *D* and *E*, causing them to return to their original positions, as shown in Fig. 2. The action of the device is very rapid and safe. The operator's hand is never in danger of being injured, because at no time does the operator place his fingers where they are liable to be hurt by the action of the mechanism. The simplicity of the tool and the safety of the device is a factor which should not be overlooked. It should be remembered that the output of a tool should not be the only consideration.

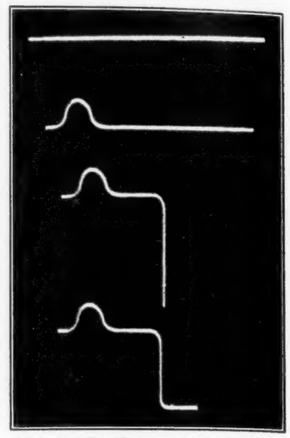


Fig. 1. The Successive Steps in the Bending Operation.

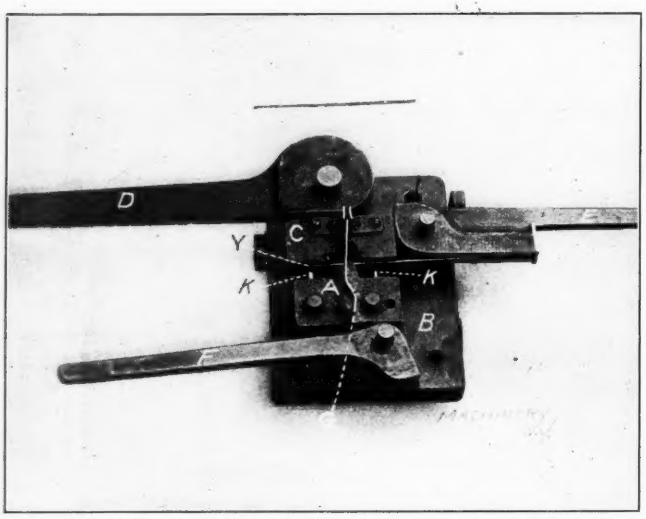


Fig. 2. Jaws A and C, which form the First Bend, opened and Wire inserted.

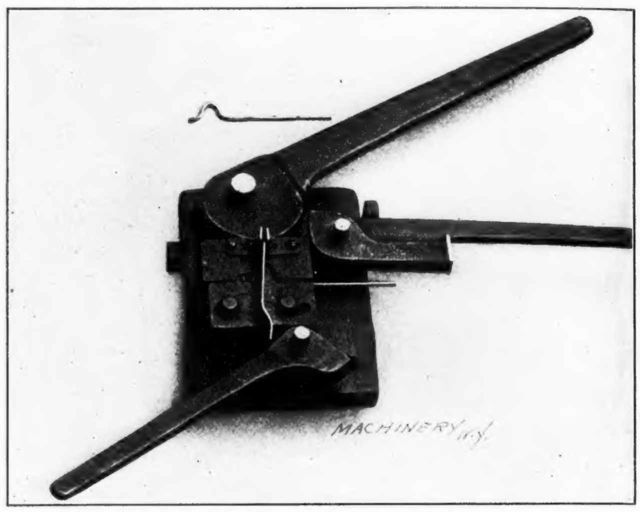


Fig. 3. Jaws closed by the Upper Lever, and First Bend made.

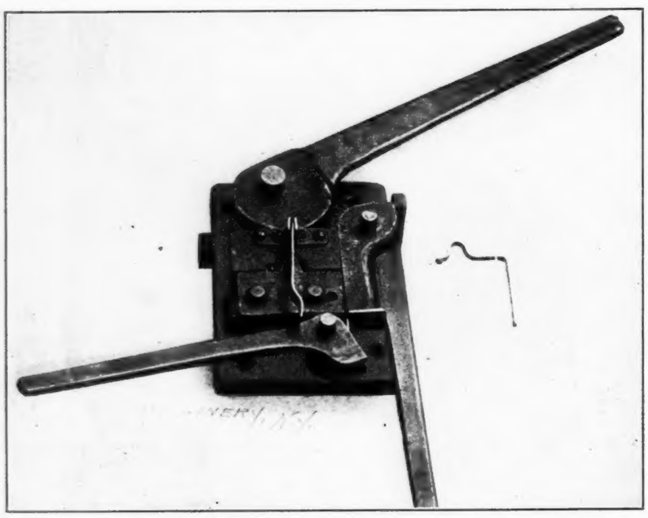


Fig. 4. First Right-angle Bend made by the Lever to the Right.

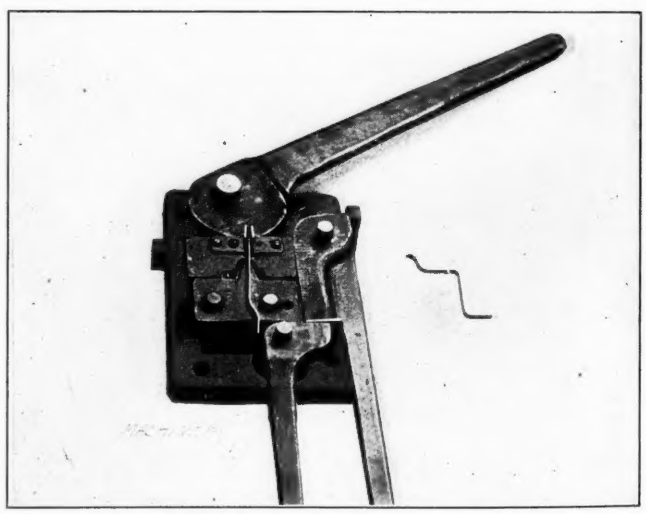


Fig. 5. Second Right-angle Bend made by the Lower Lever.

Yonkers, N. Y. G. P. CAMPBELL.

TO SET OVER THE TAIL-STOCK TO TURN A TAPER.

Referring to the article "To Set Over the Tail-Stock to Turn a Taper" in the September issue, if the only error is that caused by the depths of the center holes, these can be measured and subtracted from the length of the piece.

Another way would be to clamp a T-square or its equivalent in the tool-post or holder, set it against the foot-rule (see Fig. 1, ante) and clamp it there at the required angle; then put the work between the centers and set the foot-stock over until the square bears along the side of the piece. (This is of course for pieces already turned cylindrical and truly centered.) The square must be at the height of the centers.

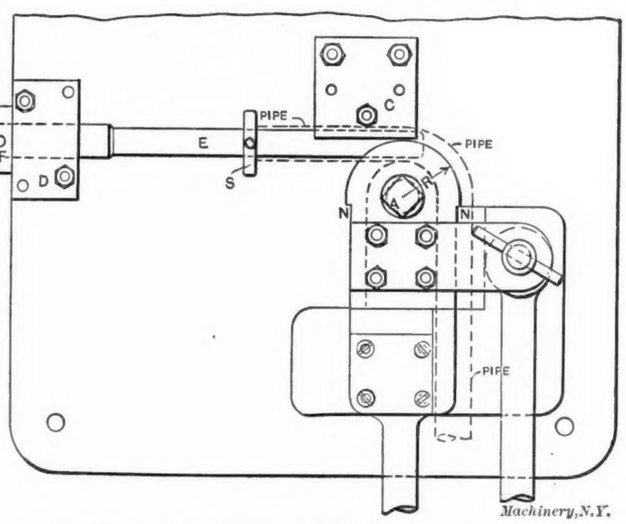
Dresden, Germany. ROBERT GRIMSHAW.

[Our correspondent doubtless knows that a correction made for the depth of the center holes, when figuring the set-over of the tail-stock for turning a taper, can only be approximate. The reason is that the location of the bearings of the piece on the centers always is uncertain, and unless the precise location of the bearings can be ascertained the calculation will be inaccurate.—EDITOR.]

PIPE BENDING DEVICE.

The writer read with interest the article in the September, 1908, issue of MACHINERY, entitled Pipe Bending Device. Having designed and followed the construction of this fixture myself, I wish to make a few suggestions which may be helpful to anyone wishing to construct a device of this kind. The success of the fixture depends entirely on the shape of the end of the horn or mandrel *E*. To get the correct shape requires a great amount of patience and experimenting, and it is not possible to give definite figures or dimensions for this shape. The pipe, in making the bend, must spin off the end of this horn, and a little too much or too little in the curvature of the end will prevent good results.

In the engraving shown in the September issue, the stop collar *S* was omitted. This collar acts as a stop for the end of the pipe, and is adjustable on the mandrel *E*. By means of this collar the bend in the pipe may be located at any



Plan of Pipe Bending Device, showing Position of Parts after making a Right-angle Bend.

required distance from the end. Backing-block *C* and mandrel *E* should be so placed that the pipe fits quite snugly between them. The mandrel should also be a good sliding fit inside of the pipe.

The radius *R* of the swivel block *A* should project at least ⅛ inch beyond the center line of the pipe, and the block should be notched at *N*, bringing the outline back to the center line. The backing-block *C* then, of course, extends only to within ⅛ inch of the center line. With a fixture made in this way, the pipe may be bent to a complete return bend. It appears that the pipe needs some extra support beyond the center line, and only short bends can be made successfully without this support.

The distance which the end of the mandrel *E* extends beyond the center line of the swivel block *A* should be experimented with very carefully. After bending a few pieces with the end of the horn placed at various distances beyond the center of the swivel block, the preferable position of the mandrel is easily determined. When finally established so that the pipe bends without buckling, the collar and the mandrel are drilled and reamed in place, and a taper pin driven in. When once located, this collar should never be tampered with. R. B. LITTLE.

Lansing, Mich.

A BIT OF RADIAL DRILL DESIGN.

Two methods of driving the spindle of a universal radial drill are shown in the accompanying engravings. Fig. 1 is the usual way, and Fig. 2 an improved method which has, in my opinion, sufficient advantages to warrant its universal adoption. Both Figs. 1 and 2 are sections through the center of the arm; *F* is the spindle, *G* the driving shaft in the arm, and *E* the face of the arm.

One of the worst features of the ordinary universal radial, is the short bevel gear shaft *H* (Fig. 1), upon the center of which the drill head swivels. It is impossible to make this bearing of good proportions, because as the distance *C* is

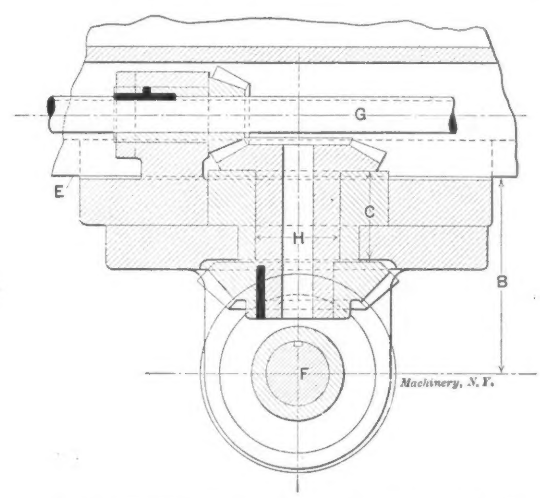


Fig. 1. A Common Form of Drive for Radial Drill Spindles.

lengthened the distance *B* is increased. Now it is an axiom in designing a radial drill, that the spindle must be as close to the arm as possible to minimize the twisting action, so that the designer is placed between the devil and the deep sea—he must sacrifice either rigidity or durability, or else compromise. He generally does the latter and evolves a machine that is neither rigid nor durable.

The new Bickford universal radial was designed to overcome these difficulties, and, as far as can be judged from illustrations and printed descriptions, a fairly satisfactory solution seems to have been attained. Long before I heard about the new Bickford machine I had been puzzling my brain for a more satisfactory method of driving the spindles of universal radials and my solution is shown in Fig. 2. On the arm shaft *G* is mounted the miter gear *J* which drives the miter *K*, the latter being forged solid with its shaft *P*. Keyed to the shaft *P* is the spiral pinion *L* which meshes with a spiral gear *M* keyed to the socket *N* in which the spindle *F* slides. The drill head swivels on the bush *O* which forms one bearing for the shaft *P*. Now let us compare Fig. 2 with Fig. 1 which represents actual practice. The length *C* of the bearing *H* is 3¾ inches, while the over-all length *D* of the bearings for shaft *P* is 11 inches, or nearly three times as long. The dimension *B*, which represents the distance from the center of the spindle to the face of the arm, is 8 inches, while *A* is only 6 inches, so that we are 25 per cent "to the good" here. Summing up, then, we find that the new type is practically 300 per cent more durable and nearly 25 per cent more rigid.

The end of the shaft *P* lends itself very conveniently for driving the feed motion, either by belt cones, as shown, or a gear box. Another advantage is that the spindle, being offset to the left of the fulcrum *D*, will go very close to the column and thus give a greater horizontal movement of the head on

the arm, though, of course, this extra length will have to be put onto the outer end of the arm. The only objection to this arrangement, so far as I know, is that the drill head will have a tendency to swivel on the fulcrum *D* under the pressure of the cut. Personally, I think that the clamping bolts will take care of this, because the twisting moment tending to swivel the drill head is only one-twelfth of the moment which tends to twist the arm around the column when the machine is drilling horizontally at a radius of 60 inches, and most firms find that a V-clamp is sufficient to resist this.

In our practice, we provide a worm and worm gear for turning the arm around the column. This arrangement pro-

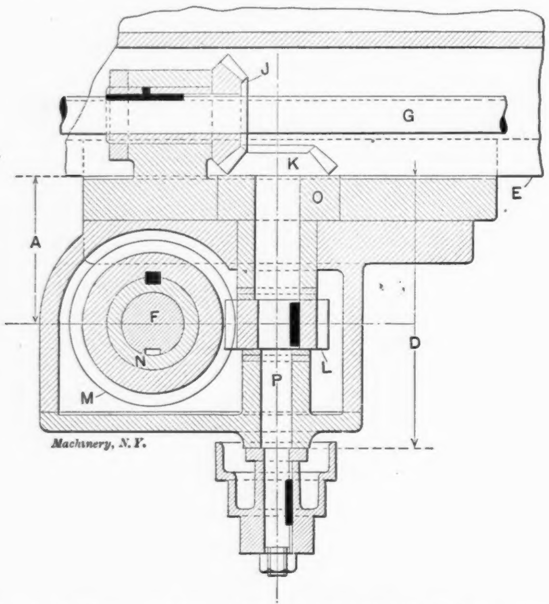


Fig. 2. An Improved Drive giving Greater Rigidity and Durability.

vides a positive stop for the column, which I think is necessary for universal radials, because if the spindle is at the outer end of the arm and swivelled to drill horizontally, the turning moment on the column clamp is enormous, and a friction clamp, in my opinion, is utterly inadequate for the work. Where very heavy cutting is to be done, it may be necessary to provide a similar arrangement for this form of drill head; but even if this had to be done, it would be very convenient for adjusting the angular position of the spindle.

RACQUET.

SETTING WORK ON THE FACE-PLATE.

A much more satisfactory way of setting the die-blank illustrated on Shop Operation Sheet No. 76, than that which is there given, is as follows:

When laying out the blank, inscribe a circle the size of the hole to be bored, heavy enough to be seen plainly. After the blank has been approximately trued up, and balanced as explained in steps 1 to 6, fasten a sharp scratch in the tool-post on a line with and facing the prick-punch mark. Bring this point (with the cross-feed) to the circle inscribed and adjust the blank until, by turning the face-plate, the circle will follow the point. The advantage of this method is a more accurate job, and if the work moves while being machined (as it is liable to do), it will be seen at a glance, and can be easily adjusted again. In truing up with a prick-punch mark, you have no way of telling if the work moves, and no way of truing it if it did. Prick-punch marks are never satisfactory for accurate work.

A SUBSCRIBER.

[It is doubtful whether the method of setting work advocated in the foregoing, has any advantage over that given in the Shop Operation Sheet referred to. If a circle the size of the hole to be bored is first scribed and the blank set by it, it is probable that the setting will not be as accurate as when the datum or central point from which the circle is scribed, is used, provided, of course, that a center tester is available. The die-blank in question, however, was laid out from a master templet, and the circular ends might have been set with a pointer without locating a central point. This method could also be employed in case the work shifted; or, assuming that part of the hole had been trued, a test indicator could be used instead.—EDITOR.]

LOCK-NUTS USED IN ENGINEERING PRACTICE.

The engraving shows two forms of nut-locks. I use the term advisedly, for most of the devices illustrated in the September Data Sheet are means for locking nuts rather than lock-nuts proper. The nut shown in Fig. 1 is made from a coil of square steel bar; it is shaped by punching and finished by milling. The hole is tapped a little below nominal size.

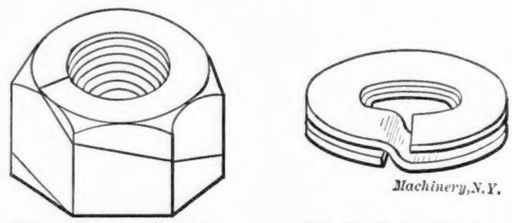


Fig. 1. Helicoid Lock-nut. Fig. 2. Spring Washer.

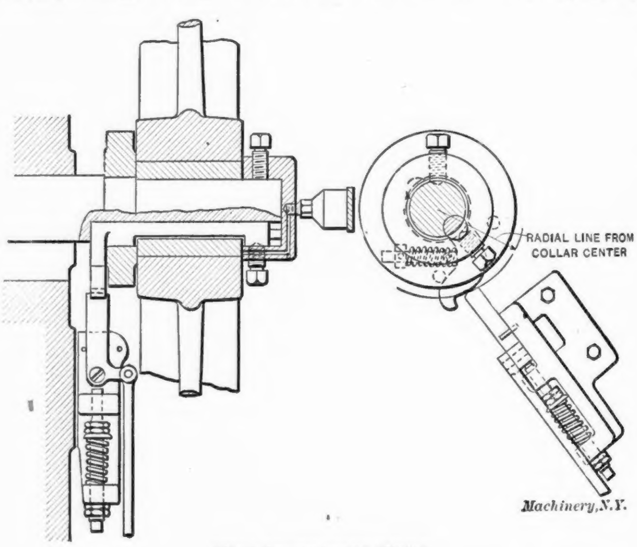
Screwing the nut on a bolt expands the coil which grips the bolt tightly. These nuts are employed, in many cases, for engine connecting-rod bolts. If properly fitted, they never work loose.

The spring washer shown, is used on rough, cheap work, as, for instance, on the ends of bench vise screws, with an ordinary nut, to retain the screw in position and to automatically take up wear on the front collar of the screw.

NUTLOCKS.

BLISS POWER-PRESS CLUTCH.

In the November issue of MACHINERY, engineering edition, we find an article entitled "Clutches for Power Presses," by Mr. Frank Mossberg (being an abstract of his discussion of the American Society of Mechanical Engineers' paper by Mr. Henry Souther, on clutches). In this article is illustrated the Bliss clutch, Fig. 4, and we wish to call attention to the fact that the illustration does not properly show the Bliss clutch, being wrong in several details. The accompanying



Bliss Power-press Clutch.

illustration correctly shows the Bliss clutch, and by comparison with Fig. 4 in the article referred to, several differences will be noted. A few of these are as follows:

The wheels are all fitted with bronze bushings. The construction of the end collar is not correctly shown in the previous illustration, the wheels in all regular fly-wheel presses being fitted with two locking points and not three; three locking points are used only when the press is geared. The end collar is fitted with a set-screw by which the clutch can be locked, in which position it is impossible to trip the press. This has been found of service when setting dies in the press. Instead of the cap bolt, shown in the illustration referred to, for holding the end collar in place, there is a grease cup by which the shaft bearing is oiled.

Brooklyn, N. Y. JOSEPH B. MCCANN,
E. W. BLISS CO.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

TURNING SOFT RUBBER—SAWING CAST IRON UNDER WATER.

The following questions are submitted to the readers for answers:

L. M.—What is the best method of turning soft rubber in a lathe, and what form of tools are required? Is a lubricant necessary, and if so, what is best?

H. M. Co.—We have been doing some experimental work sawing cast iron under water with a regular hack-saw. The cast iron surface seems to become glazed and the saw blades refuse to attack the metal, simply sliding upon it as though it were a hardened surface. Can you suggest any way of avoiding the difficulty when it is necessary to saw under water?

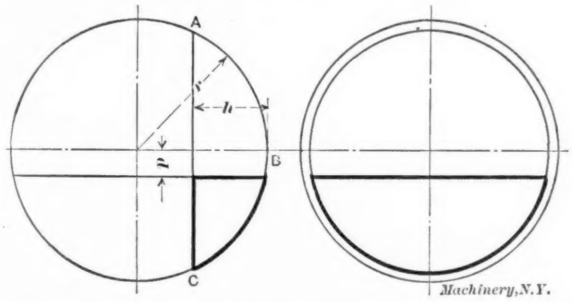
MULTIPLE THREAD SPECIFICATIONS.

P. G. and T. W.—An order came to our shop for a job in which the instructions for a square thread were as follows: "Double square thread, two per inch." We cut the thread ½ inch pitch and 1 inch lead. Our customer contends that it should have been cut ½ inch lead, or two threads per inch, then doubled. Which is correct?

A.—The customer's instructions were indefinite and could be interpreted either way. The case illustrates the confusion that arises from the indiscriminate use of the terms "lead" and "pitch." What the customer evidently desired was a double square thread, ¼ inch pitch and ½ inch lead, and if the order had specified this the mistake could not have been made. In all specifications for multiple-thread screws it is highly essential to specify both lead and pitch to avoid confusion and mistake.

OBTAINING VOLUME OF PART OF A SPHERICAL SEGMENT.

F. M. S.—I would like to submit the following problem to the readers of MACHINERY. Given the volume of a spherical segment, to determine the volume of the portion obtained by placing a plane through the segment perpendicular to its



base, as indicated in the accompanying engraving. Here the volume required is that of the portion shown in the heavy lines; the values known are r, the radius of the sphere, h, the height of the segment ABC, and p, the distance of the cutting plane from the center of the segment.

CAUSE OF DIMINUTION IN VOLTAGE FROM A GENERATOR.

J. T.—We have a direct-current 10-kilowatt, 125-volt, 80-ampere Westinghouse generator running at 1,350 R.P.M., which we used occasionally last winter. On starting up the machine, the voltage would keep steady at 120 volts for perhaps thirty minutes, then it would gradually fall to about 110 in the course of thirty minutes more. Then, if we turned the rheostat to bring up the voltage, it would gradually fall again the same as before. In the meantime the whole machine would warm up a little, but the longer it ran the weaker the voltage became. If the machine was stopped long enough to let it cool off, it would start off with the voltage strong as usual, but the longer it ran the weaker the voltage became. We carry about 75 lights, and have tried cutting out the lights when the voltage dropped, but it would not rise to normal until the machine had been stopped for some time. We know that the trouble was not caused by a slipping belt or loss of speed. What is the cause?

Answered by Wm. Baxter, Jr.

A.—The action of your generator is normal, and does not indicate that anything is out of order. When the machine starts up, the current flowing through the wire heats it, and the rise in temperature increases the resistance, so that less current passes through the field coils and as a result the magnetic strength is reduced, and this causes the voltage to drop. When you turn the rheostat to cut out resistance, the current is increased and the voltage rises. The proper thing to do to save unnecessary adjusting is to set the rheostat, at the start, so as to develop a voltage a trifle higher than the normal; then the field coils will heat up faster, and will have to heat up more before the voltage is reduced to a point where it has to be increased again. If after the machine has run long enough to get warmed up to the normal running temperature, the voltage cannot be raised to the required point by cutting out all the rheostat, it indicates that the speed is too low, and the remedy is to speed up. The increase in velocity should be made a trifle more than the increase in voltage that may be desired; thus if the voltage can only be run up to 120, and you want 125, increase the speed five or six per cent.

SPIRAL GEAR PROBLEMS.

C. K.—Kindly work out and illustrate the following problems: 1. Find the essential dimensions for a pair of spiral gears, velocity ratio 3 to 1, center distance between shafts 5⅛ inches, angle between shafts 38 degrees. 2. Find the essential dimensions of a pair of spiral gears, velocity ratio 8 to 3, center distance between shafts 9 5/16 inches, angle between shafts 40 degrees. 3. Find the essential dimensions for a pair of spiral gears, velocity ratio 5 to 2, center distance between shafts 4 1/16 inches, angle of shafts 18 degrees. 4. Give rules for calculating the change gears for connecting the dividing head and lead-screw of the milling machine table, when cutting leads that are not given on the tables furnished by the builders.

A.—1. All three of the spiral gearing problems you have given us can be solved by a simple modification of the plan described in the May, 1906, issue of MACHINERY, in an article entitled "A Method of Procedure in the Design of Helical Gears." This article, which is also reprinted in MACHINERY'S reference series No. 20, should be referred to in connection with this description.

The following reference letters will be used:

C = center distance between the axes of the gears,
D_a = pitch diameter of the pinion,
D_b = pitch diameter of the gear,
N_a = number of teeth in pinion,
N_b = number of teeth in gear,
P'' = diametral pitch of cutter,
α_a = tooth angle of pinion,
α_b = tooth angle of gear,
γ = angle between the axes of gear.

First obtain a preliminary solution by the diagram shown in Fig. 1. Draw lines AG and AG_1, making an angle with each other γ equal to 38 degrees, the angle between the axes. Locate the ratio line AE by finding any point such as O_1 between AG and AG_1, that is distant from each of them in the same ratio as that desired for the gearing. In the case shown, it is 6 inches from AG_1 and 2 inches from AG, which is in the ratio of 3 to 1 as required. Through O_1 draw line AE which may be called the ratio line. Select a trial number of teeth and pitch of cutter for the two gears, such, for instance, as 36 teeth for the gear and 12 for the pinion, and with 5 diametral pitch for the cutter. The diameter of a spur gear of the same pitch and number of teeth would be $36 \div 5 = 7.2$ inches. Find the point O on AE, which is 7.2 inches from AG_1. This point will be 2.4 inches from AG, if AE is drawn correctly.

Now apply a scale to the diagram, with the edge passing through O and with the zero mark on line AG, shifting it to different positions until one is found in which the distance across from one line to another (DD_1 in the figure) is equal to twice the center distance, or 10.25 inches. If a position of the rule cannot be found which will give this distance between lines AG and AG_1, new assumptions as to number of teeth and diametral pitch of the gear and pinion must be made, which will bring point O in a location where line DD_1 may be properly laid out. DD_1 being drawn, the problem is solved graphically. The tooth angle of the gear is B_1OD_1, or α_b, while that of the pinion is BOD, or α_a. OD_1 will be the pitch diameter of the gear, and OD the pitch diameter of the pinion.

To obtain the dimensions more accurately than can be done by the graphical process, the pitch diameters should be fig-

ured from the tooth angles we have just found. To do this, divide the dimensions OB_1 and OB for gear and pinion, by the cosine of the tooth angles found for them. If they measure on the diagram, for instance, 21 degrees 50 minutes and 16 degrees 10 minutes respectively (note that the sum of α_b and α_a must equal γ), the calculation will be as follows:

$$7.2 \div 0.92827 = 7.7563 = D_b$$
$$2.4 \div 0.96046 = 2.4988 = D_a$$
$$\overline{10.2551 = 2C}$$

The value we thus get, 10.2551 inches, for twice the center distance, is somewhat larger than the required value, 10.250

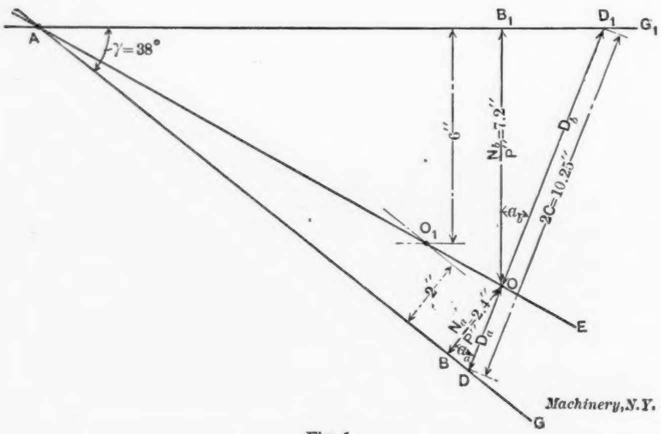


Fig. 1.

inches. We have now to assume other values for α_b and α_a, until we find those which give pitch diameters whose sum equals twice the center distance. Assume, for instance, that α_b = 21 degrees 43 minutes, then α_a = 38 degrees — 21 degrees 43 minutes = 16 degrees 17 minutes. We now have:

$$7.2 \div 0.92902 = 7.7501 = D_b$$
$$2.4 \div 0.95989 = 2.5003 = D_a$$
$$\overline{10.2504 = 2C}$$

This value for twice the center distance is so near that required that we may consider the problem as solved. The

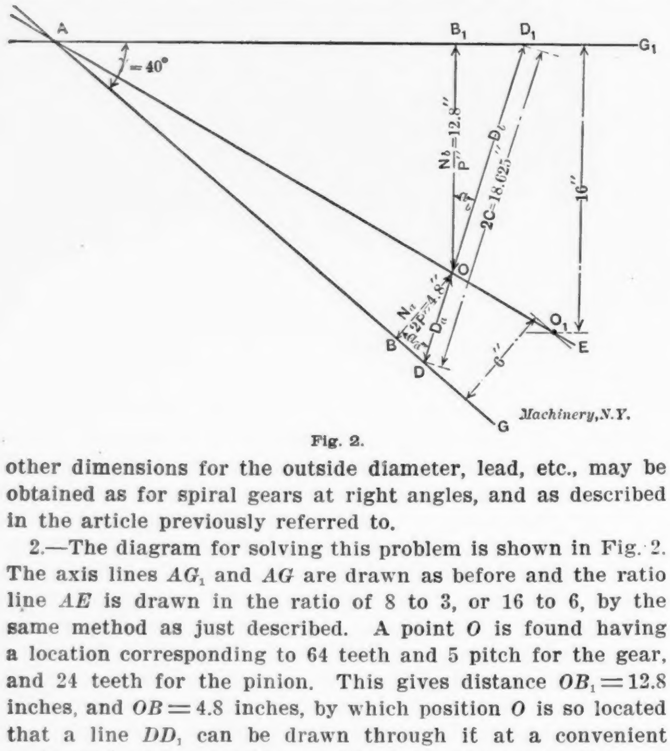


Fig. 2.

other dimensions for the outside diameter, lead, etc., may be obtained as for spiral gears at right angles, and as described in the article previously referred to.

2.—The diagram for solving this problem is shown in Fig. 2. The axis lines AG_1 and AG are drawn as before and the ratio line AE is drawn in the ratio of 8 to 3, or 16 to 6, by the same method as just described. A point O is found having a location corresponding to 64 teeth and 5 pitch for the gear, and 24 teeth for the pinion. This gives distance $OB_1 = 12.8$ inches, and $OB = 4.8$ inches, by which position O is so located that a line DD_1 can be drawn through it at a convenient angle, and with a length equal to twice the center distance, or 18.625 inches. We measure the angles for a preliminary graphical solution as before, and then by trial find the final solution as follows, in which angle α_b is 17 degrees 45 minutes, and α_a is 22 degrees 15 minutes:

$$12.8 \div 0.95240 = 13.4397 = D_b$$
$$4.8 \div 0.92554 = 5.1862 = D_a$$
$$\overline{18.6259 = 2C}$$

This gives the value of twice the center distance near enough for gears of this size.

3.—The diagram for solving this problem is shown in Fig. 3. The axis lines AG_1 and AG are drawn as before, and the ratio line AE is drawn in the ratio of 5 to 2, by the same method as just described. A point O is found having a location corresponding to 45 teeth and 8 pitch for the gear, and 18 teeth for the pinion. This gives distance $OB_1 = 5.625$ inches, and $OB = 2.250$ inches, in which position O is so located that line DD_1 can be drawn through it at a convenient angle, and with a length equal to twice the center distance, or 8.125 inches. We measure the angles for a preliminary mathematical solution as before, and then by trial find the final solution as follows, in which angle α_b is 16 degrees 45 minutes and α_a is 1 degree 15 minutes:

$$5.625 \div 0.95757 = 5.8742 = D_b$$
$$2.250 \div 0.99976 = 2.2505 = D_a$$
$$\overline{8.1247 = 2C}$$

It is often a matter of great difficulty, when the center angle γ is as small as in this case, to find a location for point O such that standard cutters can be used, and that line DD_1 can be drawn of the proper length through O without bringing D to the left of B, or D_1 to the left of B_1. It will be noticed in this case that to make the center distance come right, angle α_a had to be made very small, so that the pinion is practically a spur gear. In some cases, to get the proper center distance, it may be necessary to so draw line DD_1 that one of the tooth angles is measured on the left side of BO

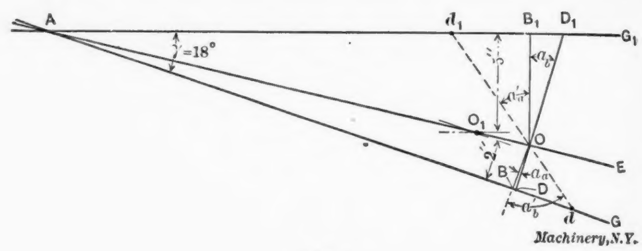
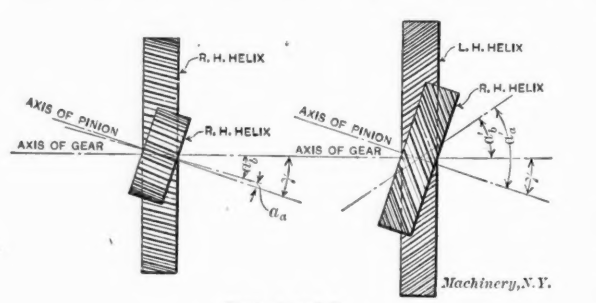


Fig. 3.

or B_1O. Such a case, for instance, is shown in the position of d_1Od. When a line has to be drawn like this, the tooth angles α'_a and α'_b are opposite in inclination, instead of having them, as usual, either both right hand or both left-hand. In Fig. 4 are shown gears drawn in accordance with the location of line DD_1 of Fig. 3, while Fig. 5 shows a pair drawn in accordance with dd_1 of the same diagram, which will illustrate the state of affairs met with in cases of this kind. This expedient of making one spiral gear right-hand and one left-hand should never be resorted to except in case of extreme necessity, as the construction involves a very wasteful amount of friction from the sliding of the teeth on each other as the gears revolve.

4.—Your request for information relating to the figuring of leads for cutting spirals in the milling machine was quite fully answered in the "How and Why" Department of the



Figs. 4 and 5.

June issue of MACHINERY. The same subject is also discussed on page 36 of MACHINERY'S Reference Series No. 18. You will also be assisted in selecting gearing which very closely fits the required ratios by studying the article entitled "How to Obtain Approximate Fractions by the Method of Continued Fractions," by Mr. Mitchell Dawes in the August, 1908, issue of MACHINERY.

INSTRUCTION OF APPRENTICES IN THE CINCINNATI MILLING MACHINE CO.'S SHOPS.

The need of a more systematic method of training apprentices than that in vogue during the last decade, has been keenly felt by all manufacturers of machines, because of the growing lack of skilled and properly trained workmen. A great deal has been written about industrial education and about apprenticeship schools, but most of what has been said of the latter has been applicable to very large shops where it was possible to devote a special department to the instruction and training of apprentices. The medium and small-sized shop would encounter the difficulty of heavy expense, if the systems followed in very large establishments were inaugurated. For this reason, any method which will successfully solve the problem of apprenticeship instruction in a medium-sized shop, will undoubtedly be of interest to all who have given this subject attention, and the following outline of the system in use in the works of the Cincinnati Milling Machine Co., Cincinnati, O., may prove suggestive to those who are contemplating the inauguration of some instruction for apprentices in their own plant.

The apprenticeship school of the Cincinnati Milling Machine Co. was organized in May, 1907, and has thus been established long enough to make it possible to form an opinion about the results obtained. The apprentices work the larger part of the time in the shop under the supervision of the regular department foremen, but receive instruction along more theoretical lines, having practical application, for two hours once a week. Forty apprentices are enrolled and divided into two sections of twenty each. Each of these sections receives instruction Tuesday and Thursday mornings, respectively, from ten to twelve A. M. The boys are paid their regular contract wage during the school hours. A large room in the main office building is utilized as a school-room, and is equipped in a manner as shown in the accompanying half-tone Fig. 1.

The phase of this particular system of instruction which is of the most interest, is the manner in which the knowledge is imparted to the boys. It would seem at first that two hours a week is entirely too short a time to obtain adequate results, particularly when twenty boys are to be instructed. This difficulty made it important for the instructor to devise some method by means of which all the boys could be kept employed, working on individual problems, leaving the instructor free to devote himself to each of them in turn; the difficulty was overcome by designing so-called "jig sheets," of which two are shown in Figs. 2 and 3. As will be seen from the illustrations, these sheets cover practical subjects, and are made up in such a form as to outline for the boy where to place the answer which he is required to obtain, and, in a general way, the manner in which it is to be arrived at. The name "jig sheet" has been adopted for the reason that* the original instruction sheet contains simply the statement of the problem and spaces to be filled in by the student. The "jig," with its explanatory drawings, is drawn on heavy bristol board and is intended to serve as a guide from which the boy is to work—hence the name. The boy places a thin bond paper sheet over this jig and traces all the lines and the illustration on the jig, on this bond paper, the paper meanwhile being attached to the bristol board by means of paper clips. The size of the bristol board is 11 by 8½ inches, so as to permit using regular typewriter letter-size paper for the tracing. When the boy has traced the jig onto the letter paper, he carries out the required calculations,

Fig. 1. One Section of the Cincinnati Milling Machine Co.'s Apprentice School in Session.

* For additional information on this subject see the following articles previously published in MACHINERY: Evening School of Trades—Rindge Manual Training School, Cambridge, Mass., July, 1908; Can a Boy Learn a Trade in a School? April, 1908; Promoting Industrial Education, May, 1907; Vital Needs of Industrial Schools for Industrial Workers, January, 1907; A Step Toward Increased Facilities for Industrial Education, December, 1906; An Experiment in Industrial Training, September, 1906.

placing the results or the whole calculation in the spaces provided. The method employed not only gives the boy an opportunity of acquiring the habit of neatness in copying from an original and an ability to copy simple drawings, but it also provides a neat and permanent record of his work.

Another important feature of this method of instruction is that there is no necessity of a definite outline of a complete course which is likely to fail to arouse the interest of the boy. On the contrary, each boy can be given a problem to work on which has some connection with his regular shop work, and his interest is thereby stimulated. Individuality is given full play, and the boy is permitted to select for himself out of a list of jigs the one that interests him, after which the instructor sits down beside him and endeavors to explain the principles involved. Should the problem require more knowledge of fundamental mathematics than the boy as yet possesses, it gives a good opportunity to instruct the boy in pure mathematics without making it tiresome or wearying to him, the boy realizing that the mathematics he is being taught are absolutely necessary for the solution of the practical problem which he has selected for himself. Thus, for instance, it was found that a boy who took but little interest in exercises in the division of decimals, worked contentedly for one full month carrying out divisions to six decimal places, calculating the angle of tapers, when the length and the diameter were given, and the tangent for the angle required.

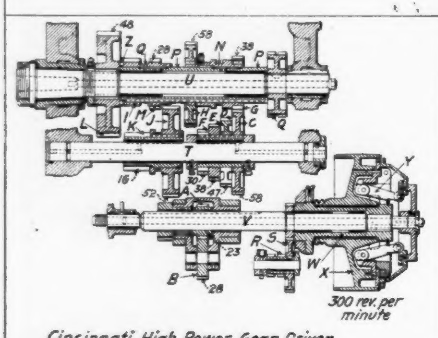
The boys are given full liberty to ask any questions and also to propose any problems occurring in their regular work which they desire to have solved, and the instructor makes "jigs" for these problems in the order in which they are proposed, referring back to former exercises when required. It will be seen that in this manner mathematics, mechanics, strength of materials, machine design, drawing, etc., may be taught simultaneously with their practical application, the boy acquiring a working knowledge of these subjects in a way which makes it possible to arouse and continually hold his interest. Mr. J. Howard Renshaw, who is the instructor of the apprentices' classes referred to, states that the system works out very successfully in practice.

In order to supplement the instruction and keep the interest of the boys, a branch library was secured from the public library of the city, numbering sixty volumes which circulate among the apprentices, the books being selected by the instructor. The cooperation of the public library has been valuable in that many books particularly adapted to apprentice education have been purchased by the public library since the inauguration of this apprenticeship school.

The president of the Cincinnati Milling Machine Co., Mr. Fred Geier, takes a personal interest in the apprenticeship school, receiving reports and information concerning each individual at regular intervals, and this has had the effect of making the boy feel that if he is successful and makes progress, his employer will know about it and take a direct interest in him. This feature is very valuable and of great importance in creating ambition and a desire for progress.

If the apprenticeship school is conceived with the object in view of not only realizing the possibility of education but with the wider view of creating mechanics who realize the full extent of their duties as well as their rights, then the inauguration of such a system of teaching apprentices as outlined above will create a different spirit among the boys. Instead of being antagonistic toward the firm, as many were when they started the course, they have come to realize that the fundamental principle of business is cooperation and that ultimately their progress and the success of the firm are closely connected. To prove a complete success, every apprenticeship school must connect the pure utilitarian studies with an understanding on the part of the students of the ethical side of their relation to their fellow-workers in the industry, whether the latter be high or low on the industrial ladder of success.

Jig No.



Cincinnati High Power Gear Driven Milling Machine.

Back Gear Ratio

$$\frac{\overset{7}{\cancel{28}}}{\underset{13}{\cancel{52}}} \times \frac{\cancel{16}}{\underset{3}{\cancel{48}}} = \frac{7}{39}$$

Spindle Speeds Back Gears	Out	Back Gears	In
$\frac{\overset{\overset{5}{\cancel{15}}}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\cancel{30}} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{6670}{19} =$	352	$\times \frac{7}{39} = \frac{2464}{39} =$	63
$\frac{\overset{\overset{75}{\cancel{150}}}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\underset{19}{\cancel{38}}} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{100050}{361} =$	277	$\times \frac{7}{39} = \frac{1939}{39} =$	49
$\frac{\overset{150}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{47} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{200100}{893} =$	224	$\times \frac{7}{39} = \frac{1568}{39} =$	40
$\frac{\overset{150}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\cancel{58}} \times \frac{\cancel{58}}{\underset{19}{\cancel{38}}} = \frac{3450}{19} =$	181	$\times \frac{7}{39} = \frac{1267}{39} =$	32

Robert Poeppelmeier. 10/25/08.

Shaper Rocker Arm. Jig. No.

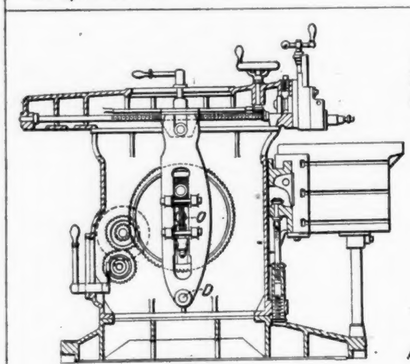


Fig. 1.

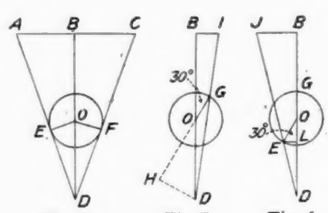


Fig. 2. Fig. 3. Fig. 4.

Given lines :- 1, 2, 3, 15 and 25		
1.	BD	31.5"
2.	OD	15"
3.	OE	5.625"
	∠ ODE	22°2'
	∠ ODE	22°2'
	∠ ADC	44°4'
	∠ EOD	67°58'
	∠ EOF +	224°4'
	∠ EOF −	135°56'
	+ : −	22:13
	− : +	13:22
	DC	33.98"
	BC	12.747"
	AC	25.494"
15.	∠ GOB Fig. 3	30°
	∠ GOD	150°
	∠ HOD	30°
	OH	12.990"
	HD	7.500"
	HO + OG	18.615"
	∠ HGD	21°57'
	∠ ODG	8°3'
	DI	31.813"
	BI	4.455"
25.	∠ DOE Fig. 4	30°
	EL	2.812"
	OL	4.871"
	LD	10.128"
	∠ LDE	15°31'
	JD	32.691"
	JB	8.745"

Victor Schinketz Date, 9-1-08

Figs. 2 and 3. Samples of Jig Sheets used in Apprentice School of Cincinnati Milling Machine Co. Designed by J. Howard Renshaw, Instructor. Sheets reduced from 7 1-2 x 9 1-2 inches.

[A comprehensive selection of the "jig sheets," referred to above, will be compiled by Mr. Renshaw with full instructions, and published by MACHINERY. We believe this system fills a gap that has existed in industrial educational literature, and that it will be an important forward step in the instruction of apprentices and shop men generally who desire to better their condition. Full announcements of the plan will be given in succeeding issues.—EDITOR.]

* * *

Wireless telegraphic communication with balloons has successfully been maintained at Brussels where an air navigator exchanged signals with a station erected on a tower in the city. Signals sent from the French military station on the Eiffel Tower in Paris were also intercepted.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

PEERLESS AUTOMATIC MULTIPLE-SPINDLE SCREW MACHINE.

A very interesting multiple-spindle screw machine (or automatic lathe, as the builders call it) has been placed on the market by the Peerless Automatic Machine Co. of Cleveland, Ohio. It follows the usual construction of such machines in being provided with a revolving spindle head, which indexes and rotates the several bars of stock, and in having a multiple tool slide and cross-slides which present cutting tools to the bars of stock in succession as they are indexed. Aside from

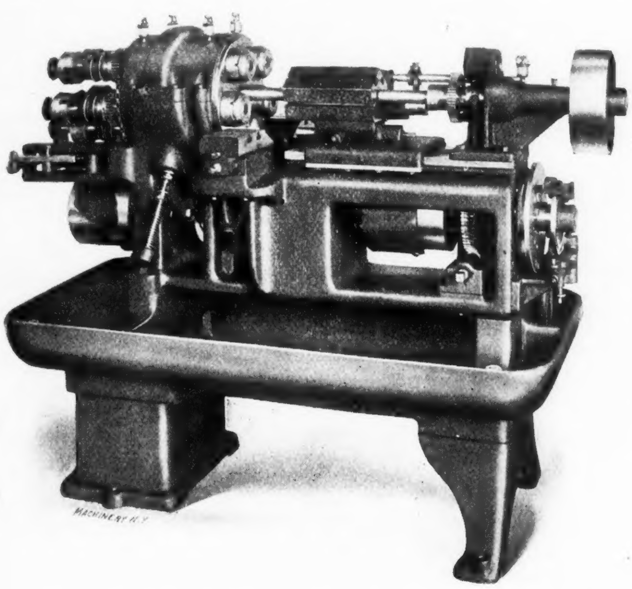


Fig. 1. The Peerless Automatic Multiple-spindle Screw Machine.

this general plan, the machine incorporates a number of new and ingenious features in its mechanism, and is worthy of detailed study.

The Controlling Mechanism of the Machine.

Fig. 1 shows the front view of the machine, and Fig. 2 the rear view. The motions of the machine are all controlled by cams on a cam-shaft driven by the high-speed driving pulley shown near the base of the machine at the left of Fig. 2. This pulley may either be clutched directly to the worm driving the tool slide cam-shaft, or it may be connected with the worm through reducing gearing and change gears, mounted on the outside of the casing containing the change mechanism, as shown in Fig. 2. The change gears provide for ten rates of feed, varying from 0.004 to 0.026 inch of advance per revolution. This change of speed gives the cam-shafts, and therefore the operating mechanism of the machine, either a slow movement for feeding, or a rapid one for such operations as indexing and locking the spindle head, operating the collets and feeding the stock, withdrawing the tools from the work, bringing them up to a cutting position, etc. The change from fast to slow cam-shaft movement is effected by dogs adjustable to any position around the periphery of the plate mounted on the cam-shaft at the extreme right of Fig. 1, and the extreme left of Fig. 2.

Taking the parts on the cam-shaft in their order as seen at the right in Fig. 1, the disk just at the left of the speed-changing dogs carries cams controlling the threading mechanism, which will be described later. The worm-wheel on the shaft just inside the frame, drives the cam-shaft from the variable speed device previously described. The large cam in the base of the machine operates the tool slide for feeding the tools to the work. The spur gear at the left of the tool slide cam meshes with the one seen at the left of the rear cam-shaft in Fig. 2, thus driving the two sets of cams in unison. The plate seen under the rear cross-slide in Fig. 2 carries cams for operating the front and rear cross-slides. These cams operate through swinging sectors with teeth cut in their periphery, meshing with racks on the cross-slide. The next cam to the right operates the locking pin for locating the spindle head, which is indexed by the large sprocket wheel and chain shown. The cam at the extreme right opens and closes the collets and feeds the stock. As in all machines of this type, it will be seen that one revolution of the cams produces a finished piece of work, the rear cross-slide cutting off a finished piece for every indexing of the spindle head.

The Design of the Spindle Head.

Coming to a description of the details of the machine, one of the points of interest is the method of indexing and locking the spindle head. This is effected by the mechanism seen in Figs. 1 and 2, but is more clearly shown in the line drawing, Fig. 3. The sprocket-wheel *A*, as previously described, is directly connected by a chain with a sprocket-wheel fast to the spindle head *B*. Sprocket-wheel *A* is normally loose in its seat on cam *C*. In a slot cut in the latter is pivoted dog *D*. One end of this dog is adapted to engage a recess inside the hub of sprocket-wheel *A*, while the outer or projecting end is in position to be operated on by stationary cam *E*. Normally, dog *D* is out of engagement with sprocket-wheel *A*, but for a fifth of a revolution (there are five spindles in the head, which therefore has to be indexed a fifth of a revolution at a time) the cam throws the dog into engagement with the sprocket-wheel, thus revolving the latter and the spindle head to a new position. Cam *E* disconnects the dog when this new position has been reached.

The turret is locked in position by a decidedly novel arrangement of locking bolt and bushing. The bolt itself, *G*, is of

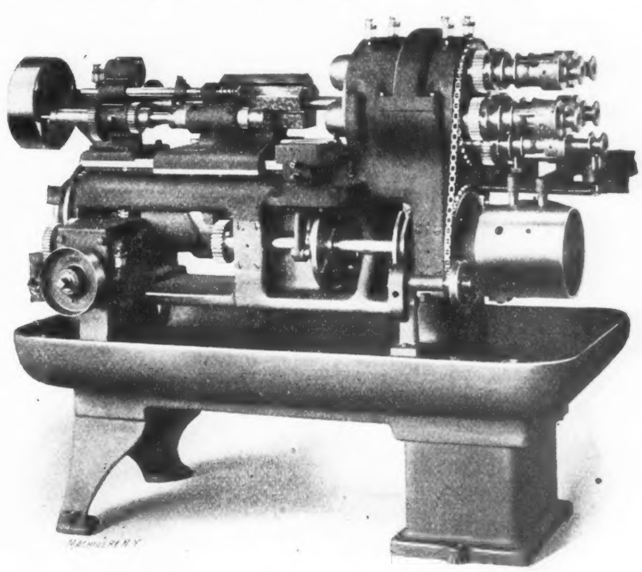


Fig. 2. Rear View, showing the Cam-shaft Drive, and the Operating Mechanism.

the usual construction. It is forced into its seat by the spring shown, and is raised by cam *F*, operating lever *H*. The cam allows it to drop into place as soon as the indexing is completed. Bolt *G* is seated in a bushing *J* in the main casting of the machine, and its conical point engages plugs *K*, equidistantly spaced about the periphery of the spindle head. Bushing *J* and plug *K* are milled as shown in the small detail in Fig. 3, so that the tapered seat for the end of bolt *G* is formed half in one of them and half in the other. By means of this arrangement the accurate positioning of the spindle head does not depend on the closeness of fit of the cylindrical part of the locking bolt in bushing *J*. The seating of the bolt half in *K* and half in *J* insures a close fit at all times, even though the fit between *G* and *J* should wear. This combination of indexing and locking mechanisms is said to give a very easy and smooth engaging and disengaging action. This is due in part to the easy and smooth action of dog *D* in lock-

ing the sprocket to the cam drum, and is accomplished by the shape of engaging surface used, and by the shape given to the acting surface of cam *E*.

The collet-operating and stock-feeding mechanisms are of the standard construction, with the exception of the provision made for changing the length of feed of the stock. The adjustment for this is shown at the front of the machine, Fig. 1, at the left. It consists of a cam lever, connected to the stock-feeding lever by a slotted link, provided with an adjustment for increasing or decreasing the amount of lost motion thus allowed. When the lost motion is entirely taken up, the feed is at its maximum. The feeding of each bar of stock is effected when it reaches its lowest position. In this position the spindle is opposite the adjustable stop shown in the base of the tool slide in Fig. 1. The feeding is thus done accurately to length, and the feed cam needs never to be removed or adjusted. Since the stock feeding is done while the cutting tools are in operation, the lost motion device just described entails no loss of time.

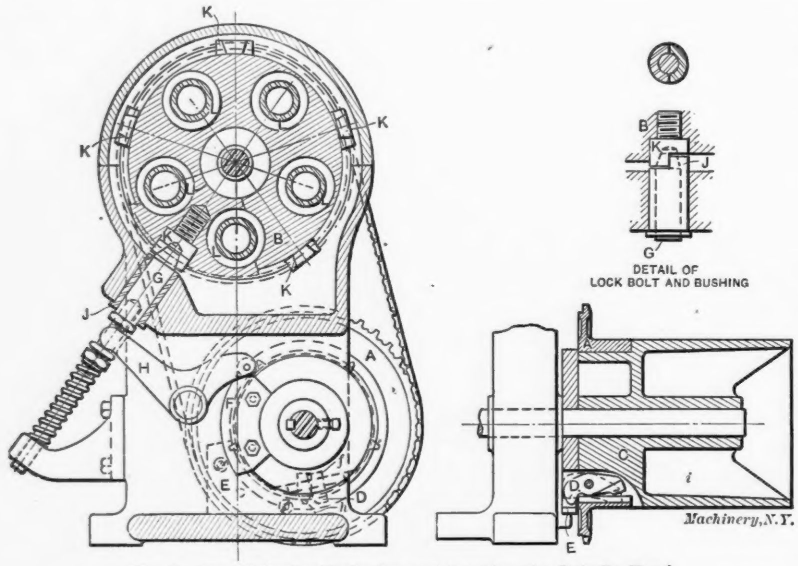


Fig. 3. The Method of Indexing and Locking the Spindle Head.

Ample provision has been made for oiling the spindle heads. The four oil cups shown in the various indexing positions of the head drop the oil into the spindle bearings. The oil flows from these bearings into oil ducts seen at *L* in Fig. 3, where it has no other escape than back through the bearings again. Oil may be independently introduced into these spaces, as well. The five main spindles are of crucible steel running in phosphor bronze bearings, the front bearing being of the taper construction with means of compensation for wear.

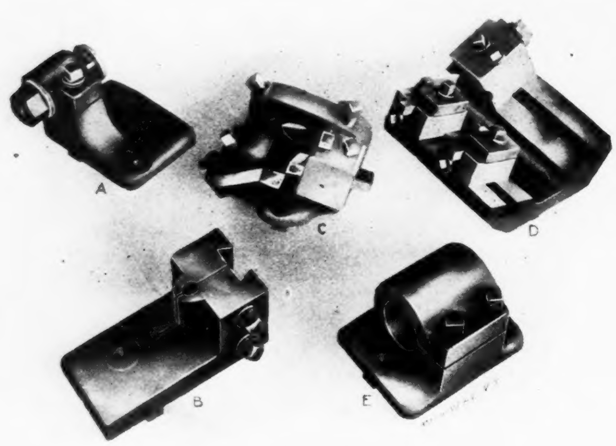


Fig. 4. A Set of Tools.

The Threading Mechanism.

The threading mechanism is best seen in the rear view, Fig. 2. The tap or die is secured to a revolving spindle carried by a tool-holder mounted on the tool slide. This revolving spindle may be connected, by either of the two pairs of gears shown, with the driving shaft of the machine, which is in turn positively geared to the spindles. The ratio of the two sets of gearing is such that one of them drives a tap or die at a slightly slower rate of speed than the work, but in the same direction, while the other drives the tap or die slightly faster than the work, and in the same direction. In the first case, the tap or die is threaded onto the work, and when the clutch connection is operated to connect the other set of gears, the higher speed releases or backs off the threading tool. With this arrangement it is possible to cut threads at about one-third the peripheral speed used for the other cutting tools, and it obviates as well the necessity for stopping and starting any of the revolving parts.

Facilities are provided for using two threading spindles, though but one is shown in the photographs. The second or auxiliary threading spindle is placed directly above the one shown and operates in the same manner, so that two dies, two taps, or a tap and die may be used. Both threading spindles can be independently adjusted and timed to cut any length of thread within the capacity of the machine. They are withdrawn from the work without reference to the movement of the tool slides. This threading mechanism is controlled, as previously mentioned, by cams on the disk at the outer end of the camshaft, just below the driving pulley.

Tools and Tool-holders.

Fig. 5 shows a close view of the machine, with the tool-holders set in position. A set of tools is shown in Fig. 4. As may be seen, the form of tool slide used does away with the necessity for holding the tools by shanks, as in the common form of turret. The long clamping surface provided at each station

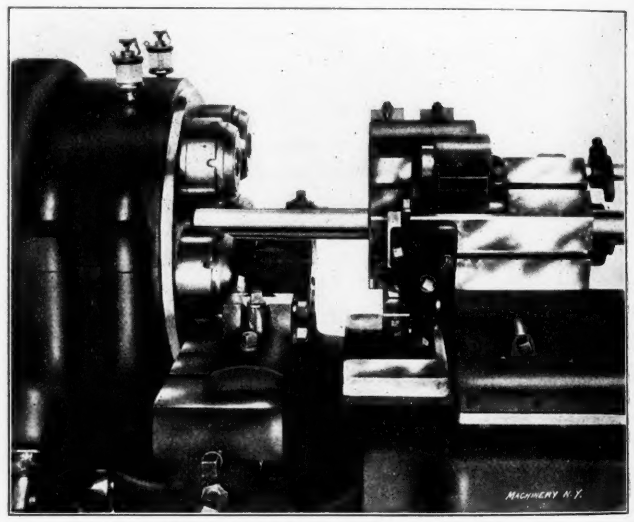


Fig. 5. Detail View of the Tool Slides.

makes it possible to secure one or more tools on each tool-carrying face, and these may be adjusted backward or forward to suit requirements. In Fig. 5 it will be seen that the cross-slides are provided with an adjusting screw for setting the depth of cut independently of the height of the cams on the cam disk at the rear of the machine; a positive stop is also provided so that in forming down to a finished diameter, the tool slide is tightly held between the point of the cam and the stop, insuring accurate work. The two cross-slides are independent of each other in their movements.

Of the tools shown in Fig. 4, *A* is a circular forming toolholder for the cross-slide, and *B* is a straight forming toolholder, also for the cross-slide. *C* is a roughing box tool; *D* is a finishing box tool provided with back rests and two blade holders (more may be used if desired), and *E* is a simple holder for such tools as drills, reamers, etc.

General Features.

As to the general features of the machine, it may be mentioned that the construction of the frame insures rigidity

and durability, as the spindle head bearing and the bed are cast in one piece. This bed is mounted on an oil pan base of large capacity, with a three point bearing, so that the machine is not thrown out of alignment no matter what the condition of the shop floor. A large oil reservoir is cast in the pedestal leg, into which the lubricant is strained, free from chips, and from which it is pumped back to the cutting tools. It will be noted that all the mechanism is accessible, the frame having been specially designed with this end in view. All the adjustments are made from the front. The inherent simplicity of the multiple-spindle machine is also plainly evident, and this simplicity has been preserved in the design. The machine illustrated has a capacity for work up to 1 inch diameter by 5 inches long. Machines of less or greater capacity can be furnished.

F. E. WELLS & SON CO. TAPPING AND THREADING MACHINE.

Fig. 1 shows a tapping and threading machine having a capacity for threaded diameters up to 5/8 inch, made by F. E. Wells & Son Co., Greenfield, Mass. This machine resembles the common type of light tapping machine in being provided with a friction forward and reverse drives, which may be engaged as desired by pressing in or drawing back on the work. It differs from the conventional type of machine, on the other hand, in being driven by a cone-pulley, allowing variations of speed to suit different sizes of taps; in obtaining the reverse by means of back-gearing contained within the cone-pulley; and in the improved facilities provided for holding and feeding the work. The machine is also provided with an oil pump and pan.

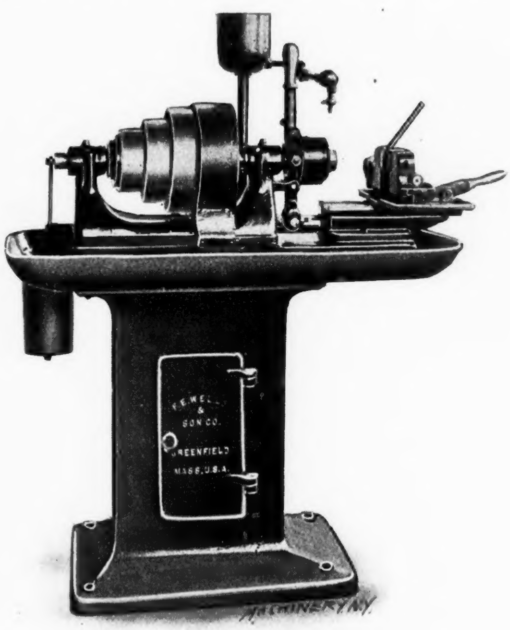


Fig. 1. A Combined Tapping and Threading Machine for Diameters up to 5-8 Inch.

The three-step cone-pulley carries an internal gear within its large diameter, which, through an intermediate rawhide pinion on a stationary stud, is connected with a smaller gear revolving freely on a spindle. A friction clutch arrangement, operated by shifting the spindle bodily, engages the spindle with the cone gear for the forward motion, or with this loose gear for the backward motion. The ratio of the gearing is such that the reverse is at a much higher rate than the forward movement. The shifting of the spindle for reversing may be effected by operating the lever shown at the front of the headstock, or by simply drawing back on the work, or stopping its further progress when its proper length or depth has been cut. A positive adjustable stop has also been provided for the work-slide, which throws the lever over and reverses the spindle at any length.

The work-slide is, as may be seen in Fig. 4, provided with two jaws operated by a right- and left-hand screw, thus making provision for centering the work. It will be noted that the bearing of the screw at the right of Fig. 4 is seated in a bracket, which is itself adjustable along the jaw guides. By shifting the position of this bracket the work may be held in any desired eccentric position, or the jaws may be brought up to the center again. The work-slide is provided with a

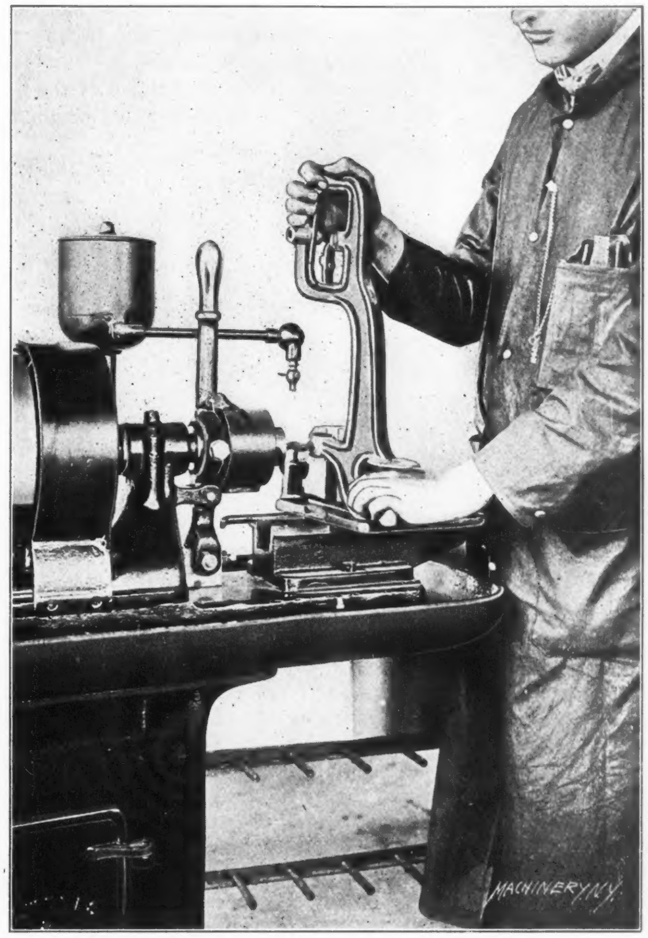


Fig. 2. Tapping a Casting held by the Hand.

hand-lever as shown, for pressing the work against the tap in starting. This is only necessary for large tapping, up to nearly the capacity of the machine. For lighter work, the slide is pushed back and forth by hand directly.

Figs. 2, 3 and 4 show various operations for which the machine is adapted. In Fig. 2 a comparatively large casting

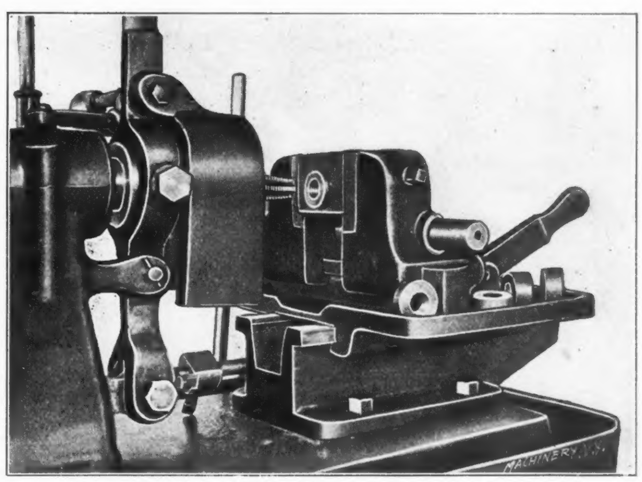


Fig. 3. Tapping a Finished Nut held in Special Soft Jaws.

is being tapped. The part of the casting operated on is backed up against the face of the vise jaws, and the whole slide is pushed by hand against the tap. When the proper depth has been reached, the adjustable automatic throw-out reverses the spindle and the tap is backed out. Smaller pieces are held by the fingers against the front end of the jaws, which are machined for the purpose. When operated in this way, the machine is as rapid on small work as the lighter machines commonly used for the purpose.

Fig. 3 shows how special soft jaws may be used in the vise to suit special work. The piece in this case is a nut, smooth finished on the outside diameter. The jaws are machined to exactly fit the work and hold it without marring. There is movement enough in the work-slide so that a long shank taper tap can be used for threading nuts if desired, in which case they may be strung on the shank of the tap, from which they are removed without taking time to reverse the spindle. Fig. 4 shows how the machine may be used for external threading as well as for tapping. Arranged as shown, it makes a convenient and serviceable bolt threading machine.

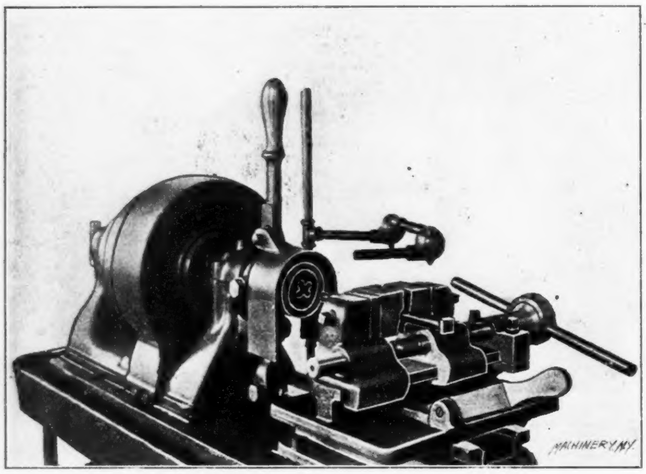


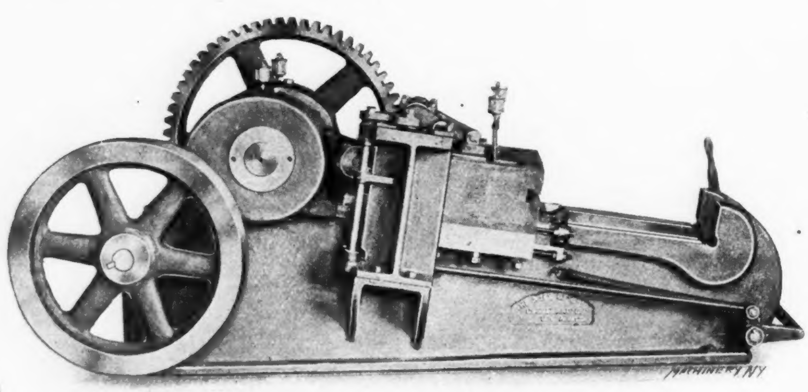
Fig. 4. Using the Machine as a Bolt Threader.

The oil pump is of the plunger type, driven directly from the rear end of the spindle. It feeds into the small tank shown at the rear of the machine, which gives a quiet, even flow of oil that does not spatter and is easily regulated. This supply tank is, of course, provided with an overflow back to the oil tank.

The capacity of the machine provides for tapping or threading up to ⅝ inch in diameter. As furnished by the builders, the machine is provided with a hardened steel vise for holding round or square stock, and a special positive drive tap chuck. This drives the tap by the squared part, and at the same time centers it by the shank.

AJAX HIGH-SPEED STOP-MOTION BULLDOZER.

An improved form of bulldozer, which is provided with a one-revolution clutch mechanism similar to that used on power presses, has been designed by the Ajax Mfg. Co. of Cleveland, Ohio. The use of a one-revolution clutch permits a much more rapid movement of the machine while still allowing the operator full control of its movements. For the No. 1 machine the movement of the cross-head takes place at the rate of 60 strokes per minute, while the time for a stroke of the largest or No. 6 size is at the rate of 45 strokes per minute. This rapid action allows a greatly increased output of work. The clutch is operated either by a foot pedal or hand lever, as may be most convenient for the operator.



Ajax High-speed Stop-motion Bulldozer.

The bed is a steel casting set on an angle to permit bringing the stock easily into place against the lower die. The cross-head is long, with ample bearing surfaces, and gibbed to take up wear in all directions while still keeping the cross-head in alignment. The gears are machine cut, and all the wearing parts and bearings are lined or bushed with bronze.

The machine is designed especially for bending work cold, and on stock which is of such material as to stand a cold bend a great saving of fuel is accomplished. The No. 3 machine will easily bend, cold, a ⅝ x 3-inch arch bar, with a pocket 8 inches deep, forming the four corners at a single operation. While it is primarily a bending machine, it can be arranged with dies to be used as a press or shear as well.

The No. 1, or smallest machine, has a cross-head travel of 5 to 8 inches (5 inches, standard); the face of the cross-head is 16 x 4 inches, and the machine weighs approximately 2,200 pounds. In the largest, or No. 6 machine, the corresponding figures are: 5 to 14 inches (10 inches, standard), 60 x 10 inches, and 24,000 pounds.

NO. 2 DALIN HAND MILLING MACHINE.

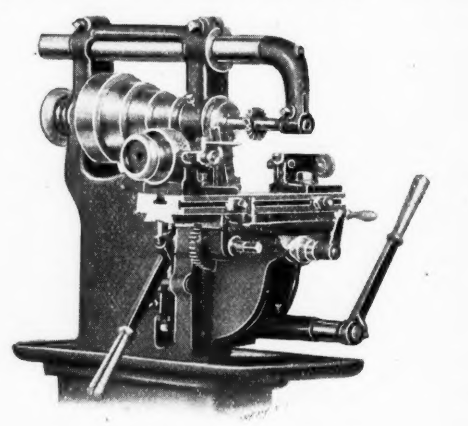
In the department of "New Machinery and Tools" of the September, 1907, issue of MACHINERY, we described the No. 1 hand milling machine built by Dalin Bros. of Rockford, Ill. A No. 2 machine of the same type has recently been designed by this firm. As may be seen in the engraving below, it differs from the older type in being provided with an over-hanging arm, and in having a larger base. It is also fitted with a small dividing head which materially increases its usefulness.

As in the older machine, stops are provided for the vertical movement of the knee on the column and for the traverse of the table on the saddle. Fine pitch screws are provided for the close adjustments of the stops, and the abutting surfaces are so placed that they will be free from chips. The spindle is regularly fitted with a draw-in sleeve and a ½-inch collet or chuck for straight shank arbors.

BARNES NO. 3 HORIZONTAL RADIAL DRILL.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., makes the horizontal radial drill shown herewith. This is similar in some respects to the builder's No. 1 machine of the same type, though it is of larger capacity, and has been provided with a number of new features which add to its usefulness and to the facility with which it can be operated.

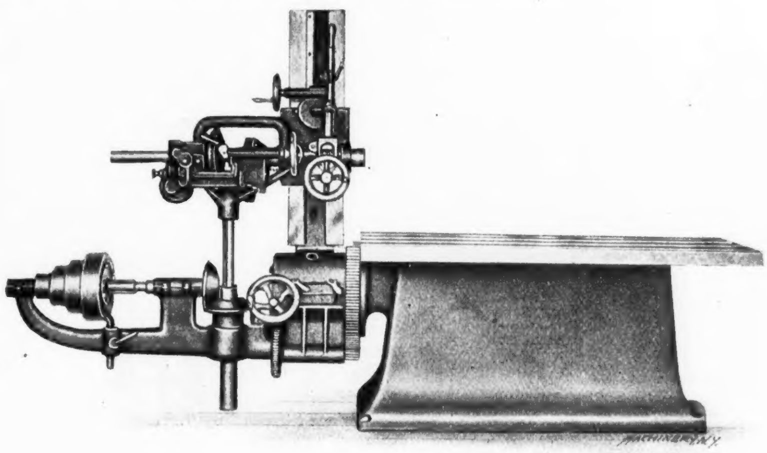
The machine is, as its name indicates, a horizontal radial drill; that is to say, the spindle has all the movements and adjustments that a radial drill would have if the axis of its column were horizontal instead of vertical. The work table of the machine is, of course, left horizontal, and the only adjustment not provided for is that corresponding to the raising and lowering of the arm on the table. This is unnecessary owing to the fact that the horizontal table allows this work to be clamped in a position that will correspond to the vertical adjustment of the arm in the ordinary radial drill. The arm carrying the spindle head and all of the driving and feeding mechanism, is supported by a sleeve which swivels about a cylindrical stub cast solid with the base of the machine. This swiveling adjustment is controlled by a gear fast to the bed, meshing with a pinion, journaled in the sleeve and operated by a worm and worm-wheel, which allows the



Dalin No. 2 Hand Milling Machine.

swiveling adjustment to be obtained with great accuracy. The spindle head is adjusted up and down the column by a rack and pinion movement, also controlled by worm gearing and hand-wheel.

The driving shaft (with the four-step driving cone and the enclosed back gears used on all the Barnes back-geared drilling machines) is placed concentric with the axis of the swiveling adjustment, so that the belt center distance is not disturbed by any of the movements of the machine. This shaft is connected by gearing with the spindle, which thus is provided with eight speeds. A tapping device is also provided, permitting the operation of taps up to 3 inches in cast iron, or up to 2½ inches for pipe taps. Three rates of positively geared feeds are provided. The drilling capacity is for



Barnes No. 3 Horizontal Radial Drill.

holes up to 3 inches in diameter out of the solid, in cast iron, or 2 inches in steel.

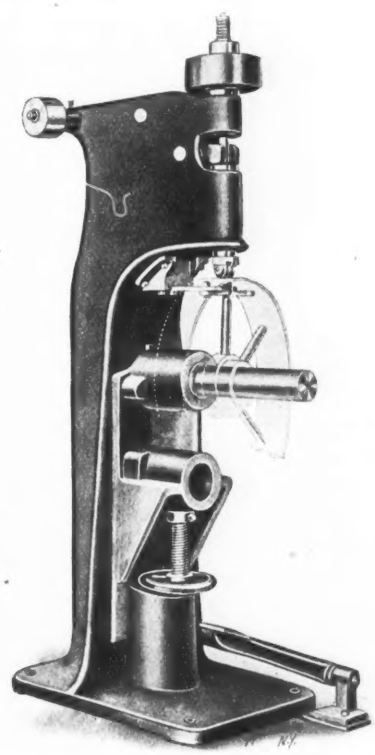
The maximum distance from the table to the center of the spindle is 29½ inches; the minimum is 2⅜ inches. The table is 24 inches wide by 65 inches long. The spindle is 1 15/16 inch in diameter and is provided with a No. 5 taper hole. It has a traverse of 18 inches. The machine weighs about 3,300 pounds. It is especially useful on work that can not readily be placed under an upright or radial drill, and is thus adapted to general machine shop use, as well as to such special lines as the manufacture of automobiles, safes, motors and engines. This type of drilling machine has been found particularly valuable for use with boring jigs, the horizontal table being much better adapted for chucking large irregular castings than a vertical angle plate.

GRANT RIVETING MACHINE FOR STEEL PULLEYS.

The Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn., has designed the riveting machine shown herewith for the special work of riveting the spokes of steel pulleys to the rims. The spokes used in these pulleys are made of round steel, 1⅛ inch in diameter, with a shoulder at the end cut down to ⅞ inch in diameter where it enters the rim. When the shoulder is made of a length to project through the rim with the proper amount of stock for heading over, the action of the machine is such that the heading can be done with scarcely any surplus metal left to be removed by grinding when finishing the wheel. The action of the machine is uniform, and will give the same results continuously, if the amount of stock left for heading is uniform.

The pulley is placed on a projecting arbor in a seat bored in the adjustable knee of the machine. Two of these seats are provided, as shown, one for large and the other for small pulleys. A wide range of work is thus provided for. The hand-wheel and screw adjusts the knee to any intermediate position to cover the range from the smallest to the largest work. Several arbors are provided, ranging in size from 2½ to 4½ inches in diameter, to support the hubs of different sized pulleys.

In this machine, the rivet is headed by a pair of rollers mounted on a horizontal pivot in the end of a forked spindle, which, in turn, revolves about a vertical axis. When this forked spindle with the rollers mounted in the end is pressed down on the top of the work, the rollers spin over the end of the stock to form the head which holds the parts together.



Grant Riveting Machine for Steel Pulleys, etc.

The action of the machine being purely rotary, it is noiseless. The character of riveting is the same as that produced on bicycle chain rivets, on which work the process has been generally used for years.

COLLIS HIGH-SPEED DRILLS.

The High Speed Drill Co. of Dubuque, Iowa, has spent two years developing a process of welding high-speed steel to a shank of low carbon steel. This has been considered a very difficult operation, but in the hands of this firm a process is said to have been developed that is commercially successful and uniformly satisfactory in its results. The specific use made of the process is in the manufacture of the Collis high-speed drills, having blades of high-speed steel and shanks of low carbon steel. The use of these two metals in this way combines the advantages of the high-speed steel for the cutting edge, while it allows the shank to be easily machined by ordinary processes to form a taper shank with a tang such as has proved to be the most satisfactory for driving drills. In samples of the work of this firm which we have seen, the welding is so well done that it is difficult, if not impossible, to see on the finished work where it is done. The details of the process are not made public.

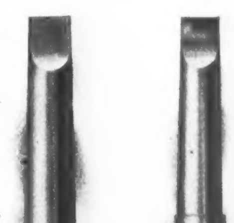


Fig. 1. Fig. 2.
Collis High-speed Drills.

Figs. 1 and 2 show a flat and a twisted drill, respectively, made by this process. They are especially effective when used in connection with air motors or electric drills, which often run at a higher rate of speed for a given size than would be allowable for drills of carbon steel. Under these conditions, the high-speed drill will work continuously for many hours without regrind-

ing, while a tool of the older material would fail at once. The flat drill is adapted for drilling iron and steel plate, structural steel and similar work. For regular machine shop work, the twisted drill is recommended. This is ground closely to size, to compete in the matter of accuracy with the best makes of twist drills. Very severe service may be exacted of it, owing to its uniform section, and to the fact that the grain of the steel follows the twist.

These drills are made in a variety of styles of shanks for blacksmith's drills, bit-brace use, etc., as well as for the regular taper shank. It is thus necessary to have special holding chucks for them. The manufacture of these tools is the main business of the makers, and every care is given to the development of the processes of manufacture which tend toward accuracy and efficiency in tools. The matter of hardening and tempering is particularly looked out for, a very complete and highly organized hardening department having been installed for this work.

VARIABLE SPEED DRIVE FOR THE GRAY PLANER.

The demand for a variable cutting speed for the planer, coupled with a constant speed for the quick return, has resulted in the past few years in the designing of a great variety of driving mechanisms. The G. A. Gray Co. of Cincinnati, Ohio, to meet the need for a variable planer drive, built, about two and a half years ago, the arrangement shown in Figs. 1, 2 and 3. Since that time the drive has been thoroughly tried out in their own shops, with results so satisfactory that they are now placing it on the market.

As may be seen, the drive consists primarily of a pair of four-step cones, of which one is mounted on the constant speed shaft (which also carries the return pulley), while the other is mounted on the variable speed shaft with the forward driving pulley. The constant speed shaft may be driven either by a belt, directly from the line shaft through a pair of tight and loose pulleys, or, as shown herewith, it may be geared to the motor shaft, making a self-contained motor drive. The mechanism includes suitable means for shifting the endless belt over the cone pulleys, for making the changes in the forward speed, and for tightening the belt after the change is made.

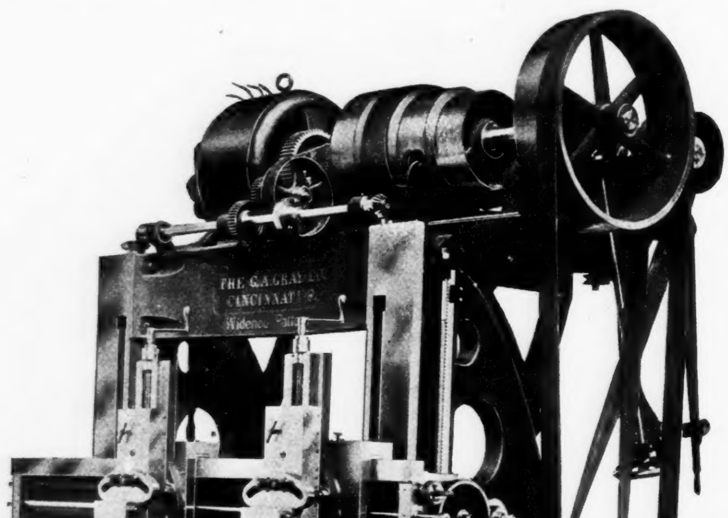


Fig. 1. Gray Planer fitted with a Four-speed Variable Forward Drive.

Fig. 1 shows a front view of the planer housings with this device mounted upon it. Fig. 2 shows a rear view, while Fig. 3 is taken from above the machine, to show the arrangement in detail. Referring to Fig. 3, the motor is geared to the constant speed shaft, which is the farther one of the two in this view. At the left-hand end this carries the heavy balanced-rim, reverse driving pulley, which thus always runs at constant speed. On this shaft is also mounted the 4-step cone shown, connected by an endless belt with the mating cone on the variable speed shaft in the foreground. This latter shaft carries the driving pulley for the forward movement, on its left-hand end. It is mounted in sliding bearings which are operated by links connected to levers on the rock-shaft shown. The long lever which depends from the rock-shaft at the left thus provides means for moving the variable speed shaft in or out, loosening or tightening the belt connecting the two cones. A clamp handle is provided for holding the adjustment at the proper tension when it has once been set. The proportions of the levers are such that it would be difficult to place a too severe strain on the belt, and the latter is of such proportions that it will transmit ample power for cutting without requiring an over-strain.

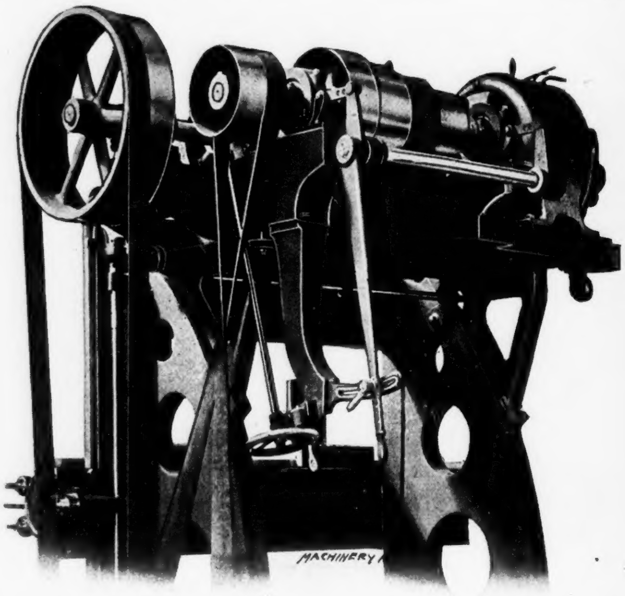


Fig. 2. Rear View of Housings, surmounted by Variable Speed Device.

In changing the forward speed, the belt is first loosened by the means just described, shifted to the desired step, and then tightened again. The shifting is effected by the hand-wheel seen just behind the lower end of the tightening lever in Fig. 3. It is also seen in Fig. 1, and more plainly in Fig. 2. This hand-wheel is connected by a shaft and bevel gears with a cam-shaft parallel to the two driving shafts. The cylindrical cam on this shaft controls belt shifters on both the idle and driving sides of the cone belt. The cam is so arranged that one end of the belt is shifted onto the smaller step of one cone before the other end is shifted onto the larger step of the mating cone. Owing to this arrangement, the shifting is effected without appreciable injury to the belts, the operation being identical with the movement of a trained mechanic in shifting a belt by hand. To further facilitate the shifting, the shoulders of the cone steps are beveled off as shown. The original belt placed on the first speed variator in the shops of the builders, two and

a half years ago, has been in use up to the present time. It has never been shortened, and has never been removed from the pulleys for any purpose since it was installed. It operates a 56-inch by 27-foot planer in the hardest kind of service.

The stationary pedestal bearings of the constant speed shaft are fitted with phosphor bronze bushings, automatically lubricated by ring oilers. The sliding pedestals for the variable speed shaft are provided with well-made ball-joint casings, also fitted with ring oiling phosphor bronze bearings. This arrangement forms a rigid universal swiveling bearing, insuring perfect alignment of the shaft bearings under all conditions. The whole device is rigidly built and, as may be seen from the illustrations, is simple and devoid of complicated or delicate parts.

The following advantages are claimed for this mechanism. There are no frictions to wear or require adjustment, and no clutches to be bruised or broken; there are no gears running loose on their shafts and thus liable to stick or cut;

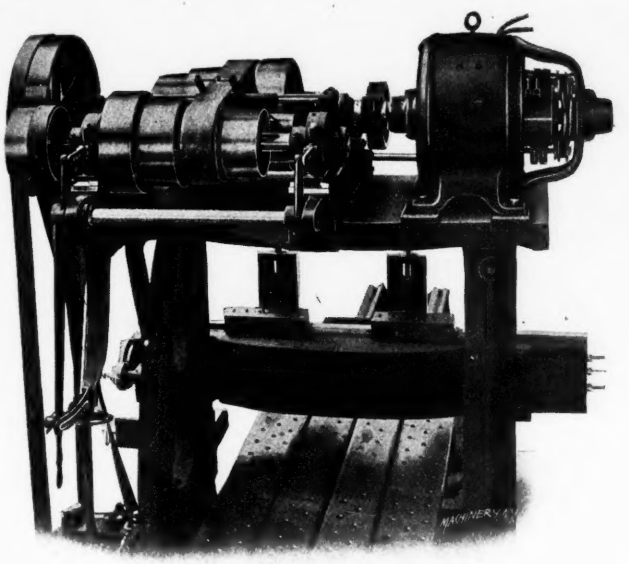


Fig. 3. Another Rear View of the Mechanism.

there are no sliding gears to be battered if carelessly shifted. The speed can be changed without stopping the motor, saving the considerable time otherwise necessary for allowing the armature and pulley to come to rest. The momentum of the two cones, supplementing that of the heavy fly-wheel pulley, reduces the strain on the motor at the moment of reversal. And, finally, the elimination of a complicated geared mechanism running at a high rate of speed, not only insures an almost noiseless drive, but does away, as well, with the vibration often met with in self-contained geared devices.

FERRACUTE ROLLING MILL.

The Ferracute Machine Co., Bridgeton, N. J., has recently built for the mint of a foreign government the rolling mill shown herewith. This mill was designed by Mr. Oberlin Smith, the president and mechanical engineer of the company. While the rolling mill as a machine is so simple that little latitude is allowed the engineer in designing it, the one here shown incorporates some features of interest and novelty.

As to general design, it will be noted, first, that the machine is motor-driven. A General Electric 50 H. P., 220-volt motor is used, the ratio of the gearing being 19.2 to 1, which gives 44 revolutions per minute to the rolls. The housings are bolted to the cast iron base or bed plate, and are provided with phosphor bronze boxes for the roller bearings. The rolls themselves are made of a substantial metal of a close texture. They are ten inches in diameter, and the distance between the housings is nine inches, thus adapting the mill for rolling strips of metal nine inches in width and from 0 to ½ inch in thickness. It will be noted that the gears and roller ends are protected by guards and all the working parts are accessible.

The adjustment of the rolls constitutes a particular point of interest in this machine. The upper roll is supported by

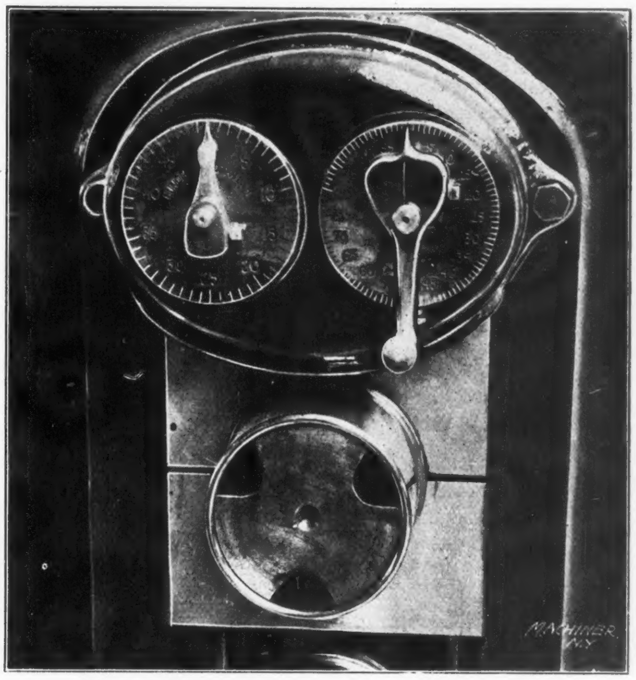


Fig. 1. Dials for Reading the Adjustment of the Rolls.

four heavy springs under a compression considerably in excess of the weight of the roll so that it is supported at all times against its abutment, whether or not there is any stock passing through the mill. This prevents the formation of a film of oil between the journal and its bearing, and the consequent inaccuracy in the thickness of the rolled metal. The adjustment in each housing is effected by wedges. These wedges are shifted by a screw operated by the crank shown in the detail view, Fig. 1. The screw which moves the wedges in and out is connected by a train of gears with the dials, in such a way that these latter indicate accurately the thickness of the rolled strip. The dial at the left reads to hundredths of an inch, and the one at the right to ten-thousandths. One revolution of the crank moves the dial hand on the left one

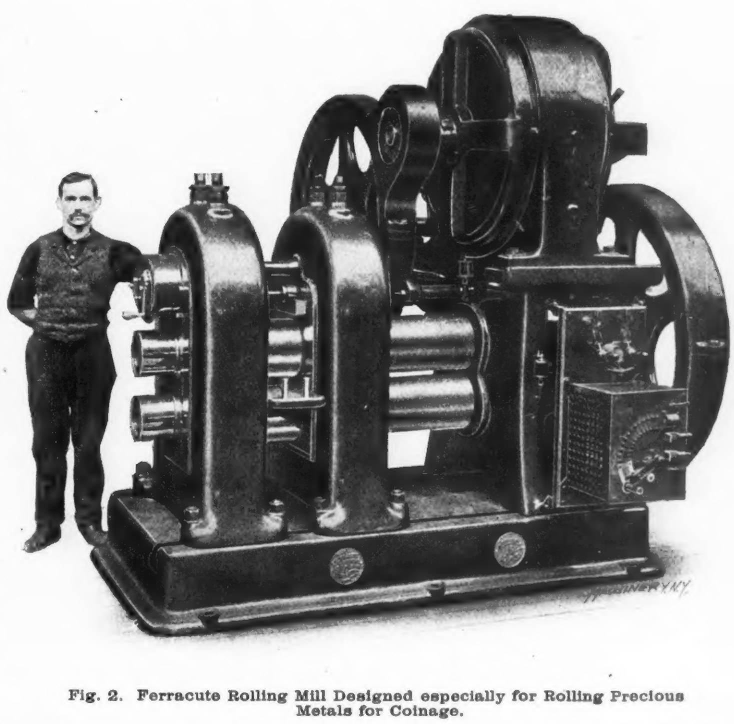


Fig. 2. Ferracute Rolling Mill Designed especially for Rolling Precious Metals for Coinage.

notch or 0.01 inch. If it should be desired, for instance, to roll a strip 0.2506 inch thick, the crank would be turned until the dial hand at the left pointed to 25, and the dial point at the right to 6.

The extreme length cf the machine from right to left is 8 feet 1 inch, the width is 6 feet 8 inches and the height 7 feet 9 inches. The total weight, including the motor, is 25,000 pounds.

BULLARD 24-INCH VERTICAL TURRET LATHE.

The Bullard Machine Tool Co. of Bridgeport, Conn., is building the 24-inch vertical turret lathe shown herewith. This machine is, in its general features, a smaller size of the 36-inch turret lathe, described in our department of "New Machinery

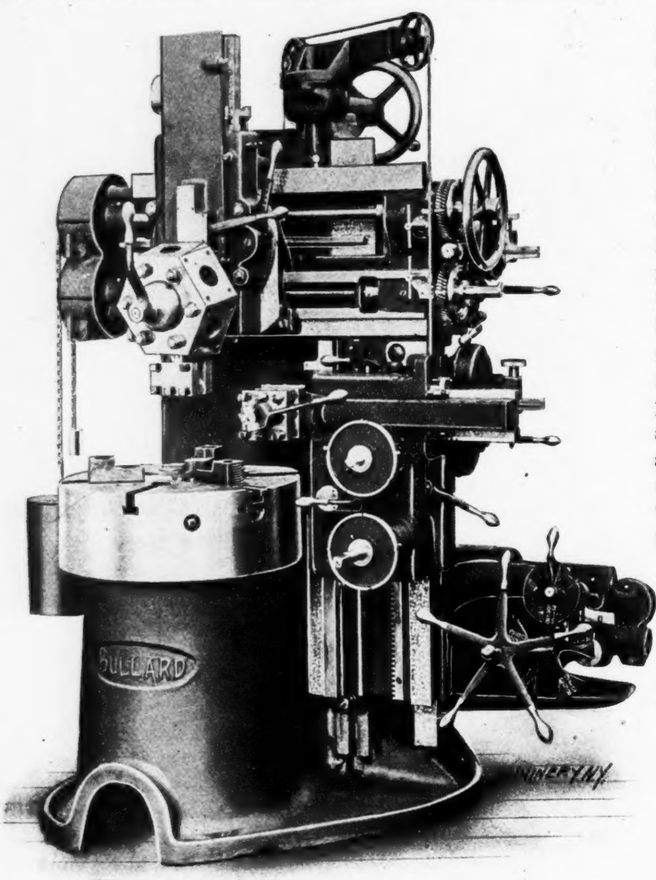


Fig. 1. Front View of the Bullard 24-inch Vertical Turret Lathe.

and Tools" in the October, 1907, issue of MACHINERY, to which reference should be made for a general description of this type of machine. It has been found that this tool, on account of its smaller size, can be handled more rapidly than the 36-inch machine. This means that the production is materially increased on work within its range, as will be understood by anyone who has watched the operation of a turret lathe of this type, and has thus had an opportunity to see to what a remarkable extent the actual cutting time can be reduced.

The arrangement of the controlling mechanism is identical with that of the larger machine. The speed changing mechanism was described in detail with reference to the first machine to which it was applied (see the December, 1905, issue of MACHINERY). As will be remembered, this gives 15 changes of speed, by means of handles which can be operated instantly, and which are so interlocked as to make it impossible to make a false move. A brake is incorporated in the mechanism, which stops the table automatically in making changes that cannot be effected at high speed. It gives the operator, as well, the use of the brake in stopping the table quickly for removing or adjusting the work. These speed changes are effected by means of the pilot wheel and levers shown at the right of the base of the machine in Fig. 1. The feed changes and control are entirely independent for the main and side turrets.

Improvements in Details.

Among the changes which have been made from the design of the larger machine, may be mentioned the improvement of the bed construction, which has been widened out to directly support the ways for the side rail, and to generally increase the stability of the machine. A heavy support has also been furnished for the lower end of the table spindle, which tends to reduce the torsional strains on the bed. The principle of providing narrow guiding surfaces for all sliding parts has been employed throughout the machine. The cross and side rails have been made a unit and are guided on one continuous narrow bearing which serves to maintain positive alignment at any height of adjustment.

Another improvement to which attention may be called, is the construction of the friction clutches used throughout the machine in the control of the feed and machine changes, and the rapid movements. This new form of clutch is shown in detail in Fig. 4, which illustrates the cone of gears giving the five spindle speeds controlled by the pilot wheel shown in Fig. 1. Each of these five gears *A*, revolves loosely on a clutch ring *B*, which is in turn supported on a collar *C* keyed to the hollow shaft *D*. Rings *B* are expanded to cause the different gears to drive the shaft, by levers *E* operated by a plunger *F* which passes through the shaft in its central bore. In this central bore is seated the plunger *G*, which is shifted lengthwise by rack teeth cut on its outer extension, engaging a pinion at the end of the pilot wheel shaft. The inner end of this plunger carries a series of five plugs *H* which, as the plunger is shifted lengthwise, raises the five plungers *F*, one after the other in succession, connecting the five gears, one after the other, to the shaft *D*. A particularly ingenious feature of this clutch is the means provided for adjusting it. These five plugs *H* back against adjustable headless screws, by means of which they may be set out more or less. In

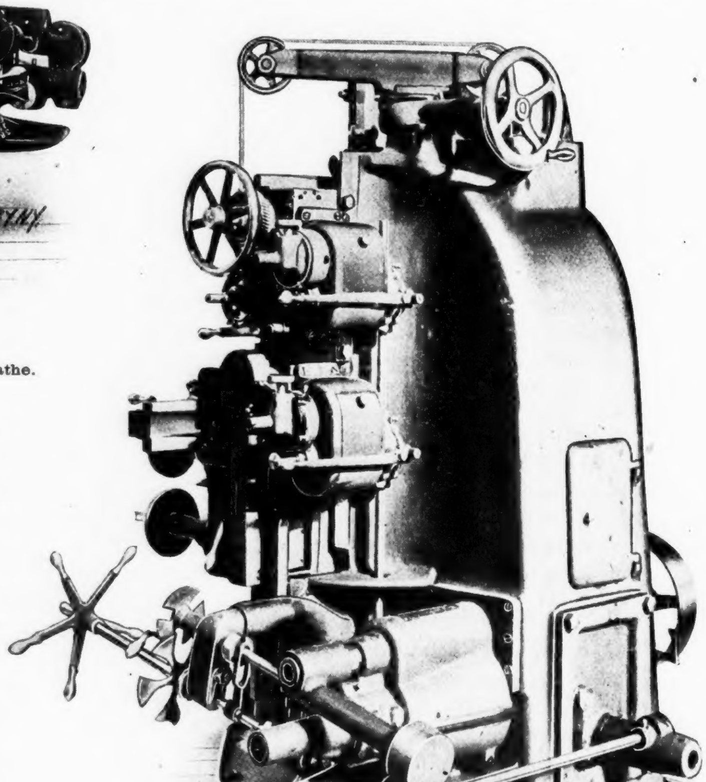


Fig. 2. The Driving and Feed Mechanism of the Bullard Turret Lathe.

adjusting the clutch, therefore, the plunger is removed from the machine and taken to the bench, where the plugs for the clutches requiring adjustment are set out. The adjustment is then locked by means of the locking screws provided, after which the plunger is returned to the machine. It will be seen that the clutches themselves are adjusted by what may be called an "absent treatment." In the older machine, an adjustment was provided at the ends of clutch levers *E* which, however, were made slender enough to have considerable

spring, the idea being that it would thus not be necessary to adjust them during the life of the machine. It has been found more satisfactory, however, to make these levers stiff and strong, and to provide an easily effected adjustment.

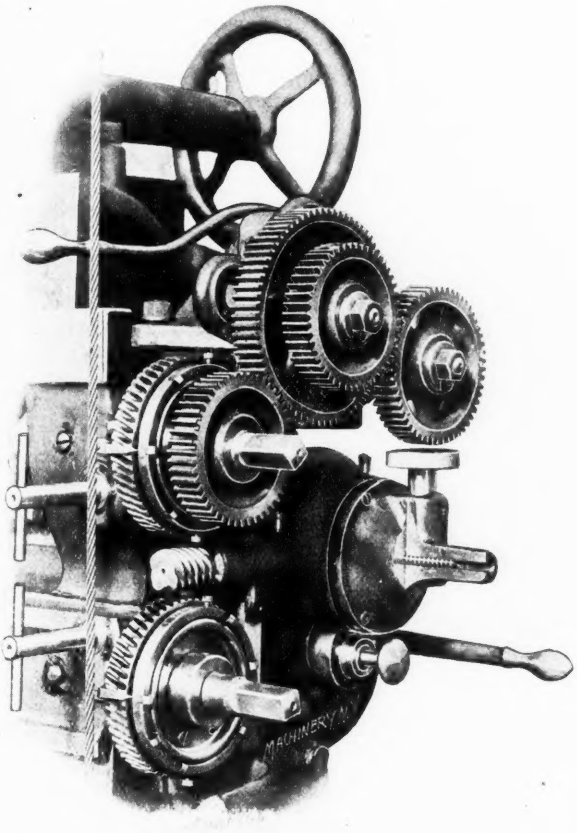


Fig. 3. View of Feed Gearing Set up for Thread Cutting; Indicator Clips for Setting Tools and Stopping Cuts are also shown.

The clamping of the side head has been improved. The clamp lever acts on the head by a cam movement, giving first a rapid action for bringing it down into place, and then a slower action for firmly locking it in position. It is unnecessary with this arrangement to swing the lever around so far that there is any possibility of interference with the work or the turret tools.

Another new feature is the provision made for running the turret head beyond the center stop on the cross rail. This is best seen in Figs. 6 and 8, the latter of which shows an example of an operation in which this comes into use. In this case it is convenient to move the head beyond the central position to allow the simultaneous use of the side head on the other side of the work. The center stop, as shown in Fig. 6, is in the form of a half bushing, which is swung into place between the nut on the turret slide, and an adjustable threaded nut abutment at the left-hand bearing of the cross-

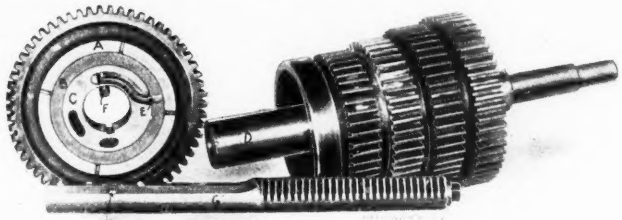


Fig. 4. Construction of the Clutch generally used in the Machine.

feed screw. This half bushing is thrown back out of the way by a conveniently placed knurled knob, whenever it is desired to move the turret beyond the central position.

An improvment has also been made in the matter of gibbing the turret slide. This is now provided with a universal adjustment (see Fig. 5) so as to provide for taking up lost motion in any direction, making it possible to keep the holes accurately centered with the axis of the table throughout the whole life of the machine. Owing to the provision of an adjustable abutment for the center stop, no jib is necessary at the left-hand side surface.

Conveniences of Operation.

The usefulness of the rapid traverse for the vertical and cross movements of the turret on a machine as small as this, might perhaps be questioned by a mechanic who has never seen it operated to its full capacity. The use of multiple tools, high speeds, and heavy feeds, can be carried to such an extent that the operating time becomes a matter of the

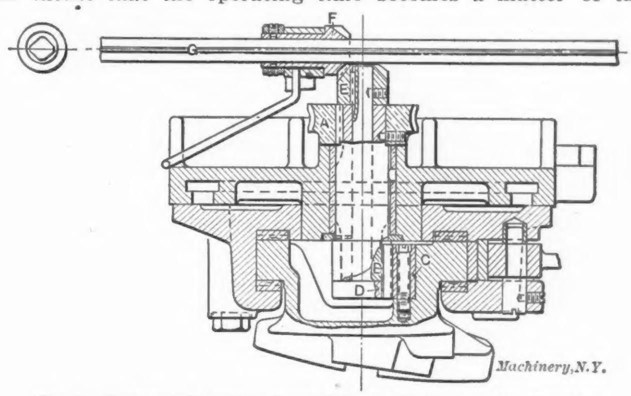


Fig. 5. Horizontal Section through Turret Slide showing Counter-balance Connection.

utmost importance. The workman easily gets into the habit of setting the tools entirely by the rapid traverse, throwing the power feed in as soon as he has thus brought the cutting tool to position. More important than this, however, is its relation to the matter of the accuracy and rigidity of the machine. As is well known to mechanics, where the slides

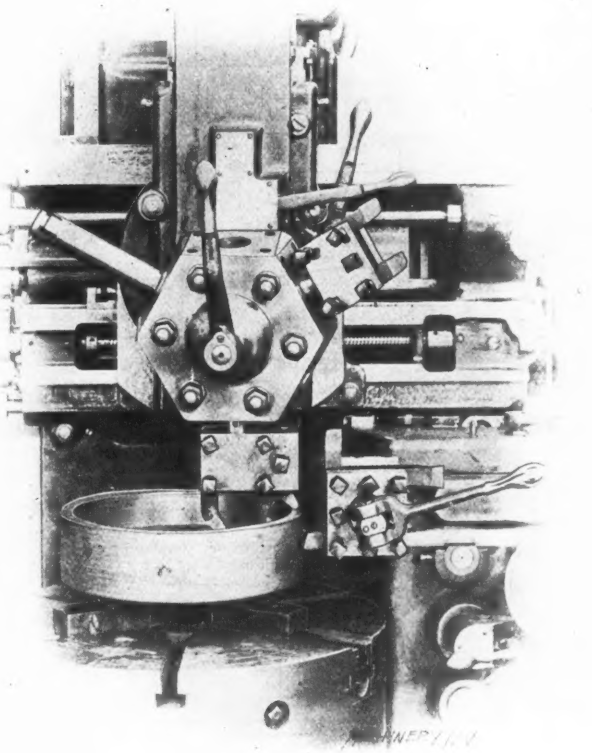


Fig. 6. The First Operation in Machining an Automobile Fly-wheel.

have to be adjusted by hand the gibs are almost sure to be left much more loosely adjusted than is demanded by the requirements of accuracy and rigidity. By keeping the gibs firmly adjusted, and using power to move the slides rapidly against the resistance of this firm adjustment, the best results are obtained.

Fig. 3 shows the feeding end of the cross rail as arranged for thread cutting. When so arranged, the gear box is cut out and the connection between the feed shaft and cross feed screw is made by change gears, as shown. The feed shaft revolves with the work table in the ratio of 1 to 1, and the

connection with the screw is made by a one-tooth clutch. By using this clutch lever in connection with the rapid traverse device, it is not necessary to stop or reverse the spindle, the operation being similar to that which is possible on some makes of lathes where the corresponding mechanism is provided.

Fig. 3 also shows very plainly the indicator clips used on the large dials provided for each of the cross movements. These clips are numbered to correspond with corresponding faces in the cross and vertical turrets, and are used both for setting the tools, and for limiting the feeding movements. Automatic stops are not provided, as the workman is kept so busy that he could not run two machines under any circumstances, and it would be difficult to devise a system of automatic stops which would give the requisite range of action, and still preserve the accuracy which may be obtained by this method of reading the dials.

An ingenious method of counter-weighting the turret slide is used on this machine, which, so far as we know, has not been previously described. It is best seen in Fig. 5, which is a section on a horizontal plane through the rack pinion shaft which controls the turret slide. The feed for the turret slide is received from the splined shaft of the cross rail through worm gearing at *A*. Worm-wheel *A* is keyed to the sleeve *B*, whose inner end has pinion teeth cut on it meshing with the rack *C* of the turret slide. A narrow pinion *D* also meshes with this rack. This pinion has a shank extending through the sleeve *B*, and has keyed to it at the other end a bevel pinion *E*, meshing with a similar mate *F*, which is supported by the saddle and fits the squared shaft *G*. The

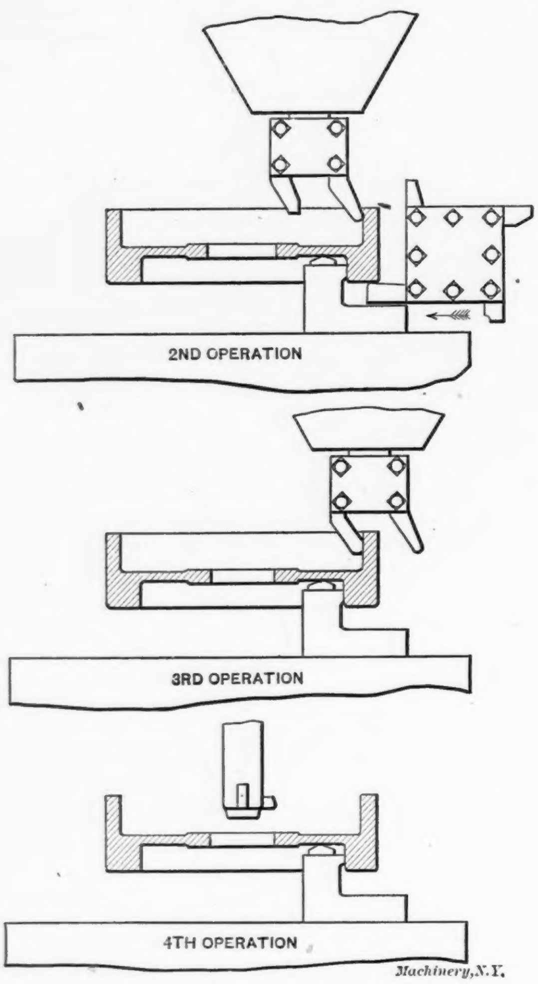


Fig. 7. The Remaining Operations on the First Setting.

outer extremity of this squared shaft at the left-hand end of the cross-rail, carries a sprocket over which runs the chain from which the counter-balance is hung (see Fig. 1). It will be seen that by this arrangement perfect freedom of position is allowed the slide, without interference with a system of wire loops and idler pulleys. At the same time, back lash is entirely taken up, as rack *C* is always firmly held against the resistance of pinion *B* in one direction, operated by the feed, and pinion *D* in the other direction, controlled by the counter-weight. It will be noted from Fig. 5 that the turret head is set at an angle in both the horizontal and vertical planes. This is done to clear, with over-hanging tools, both the rear of the tool slide and the side head as well.

Figs. 6, 7 and 8 illustrate typical operations on this machine. The work in question is the machining of an automobile flywheel which has to be finished all over. The first operation employs four tools acting simultaneously. The three in the main turret, face the hub, the web and the rim of the pulley,

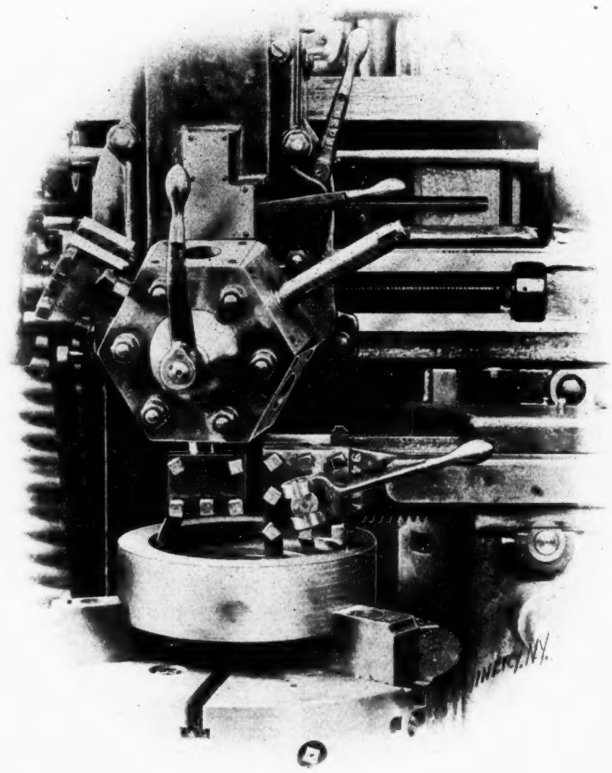


Fig. 8. The Machinery as arranged for Completing the Work on the Second Setting.

while the tool in the side head turns the outside diameter. The outside diameter is finished and carefully rounded by other tools in the side head. In the second operation, the under face of the rim is finished and the inner diameter of the rim is rough turned. In the next operation the side head is moved out of the way, and the same tool-holder in the turret is used for finishing the inside of the rim. The final operation at this setting is the boring of the central hole, which is done with the bar, noted in this department in the last month's issue of MACHINERY. It carries interchangeable single-ended and double-ended boring blades, making possible the complete finishing of a hole at one setting of the turret.

The remaining operations are made with the work reversed and held in soft jaws, accurately bored to fit the finished outside diameter of the wheel. The turret head, as shown in Fig. 8, finishes the inside of the rim, while the side head carries tools for facing the web and hub, and for rounding the corners of the rim.

General Features and Dimensions.

It will be seen that this machine is essentially, as the manufacturers claim, a turret lathe, the matter of its being vertical not changing its nature, and merely resulting in a rearrangement of the position of the handles and driving mechanism, and the rearrangement of some of the sliding surfaces. It is intended for exactly the work done on the horizontal turret lathe. The completeness of adjustment and facilities provided, are the result of long experience. It is not probable that any firm which had not been building machines of this type for many years, would have had the courage to carry all these adjustments and operative facilities into the design of a machine as small as this one.

The machine swings 26 inches in diameter, 18 inches in height under the cross rail, and 26½ inches under the turret

face. The main turret has a vertical movement of 18 inches, and will face work 26 inches in diameter. The side head has a vertical travel of 19 inches and a horizontal travel of 13 inches. The net weight of the machine is 7,800 pounds.

GENERAL ELECTRIC CO.'S ELECTRICAL FURNACE FOR HEAT TREATMENT OF STEEL.

The General Electric Co. of Schenectady, N. Y., has designed a furnace for general use in annealing, hardening, and tempering steel. The advantage of a furnace of this construction for annealing and hardening is that it gives the prime requirement—a furnace of constant temperature. It is difficult to do this with coal and gas furnaces, owing, for one reason, to the large area for radiation, exposed to the air. The electric furnace also presents the advantages of more simple and accurate temperature regulation. In this new design the work is placed in a bath of metallic salts which are reduced to the liquid state by means of an electric current. As soon as these salts reach a liquid condition, the temperature may be easily regulated by varying the amount of current passing through the bath. An alternating current is used, which is transformed to give the proper current strength for this work.

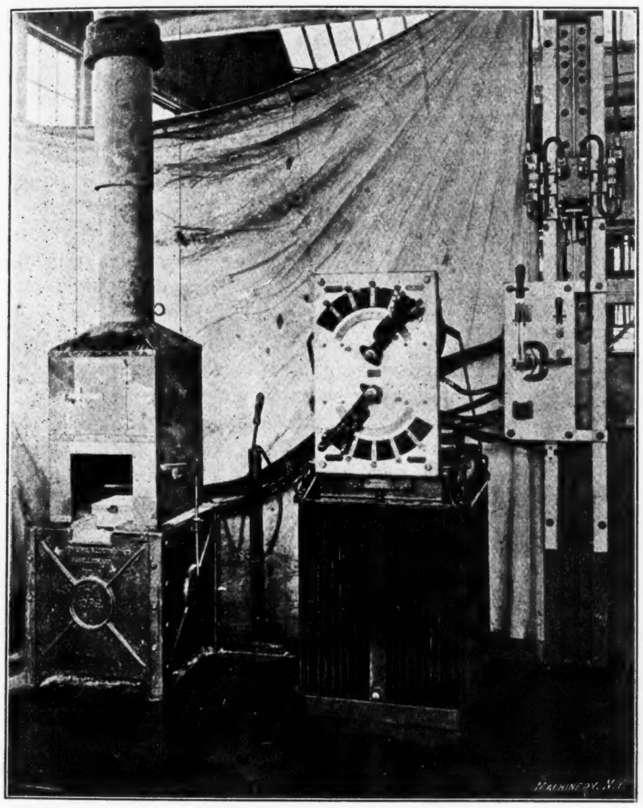


Fig. 1. Apparatus for the Treatment of Steel in an Electrically-heated Bath.

By means of this method of regulation, a temperature from 250 to 1,350 degrees Centigrade may be obtained. This temperature will remain uniform throughout the bath, except at the surface, where, owing to radiation, it is slightly lower.

The outfit, as shown in Fig. 1, is that installed in the die department of the Schenectady works of the builders. As may be seen, it consists of the furnace with its hood suspended from above; a regulating transformer with the controlling switch; the switchboard with the necessary ammeter and voltmeter; and the connecting line with its fuses. The regulating switch is provided with a sufficient number of contact points, to give, as stated before, practically any desired temperature between the limits of 250 and 1,350 degrees Centigrade.

A sectional view of the furnace is shown in diagram form in Fig. 2. It consists of a fire-clay crucible surrounded with an insulating material, usually asbestos, which rests in a fire-clay box. The whole is supported in an enclosing case of iron. Two electrodes are provided, one at each side of the crucible, and in direct contact with the bath at all times. To start the furnace, an arc is established across the broken mass of salts by means of an auxiliary electrode, as shown. In a very short time the solid mass is in a molten condition. After the bath has reached its proper temperature, that portion of the material which is to be hardened, is submerged in it and is allowed to remain until it attains the same color as the bath, when it is removed and tempered in oil or water, as the case may be. The bath completely fills the crucible and, in the Schenectady works, consists of equal portions of barium and potassium chloride. The ultimate temperature depends on the relative proportions of the chloride. The higher the percentage of barium used, the higher the temperature may be carried. When using the bath for softening steel, it should be maintained at a temperature of 250 degrees Centigrade.

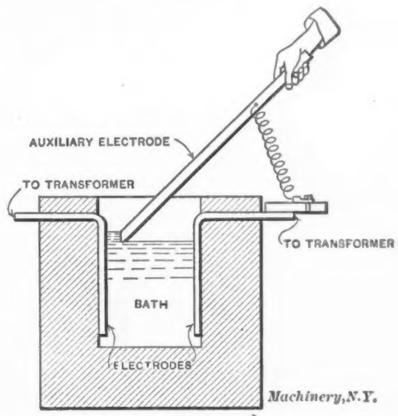


Fig. 2. Starting the Arc for Melting the Salts in the Bath.

The advantages of an electrical furnace for hardening and tempering may be summed up as follows: There is little chance of oxidation, as the material, while being heated, does not come in contact with the air. All parts of the tool are subjected to the same degree of heat at all times, thus preventing any possibility of over-heating or of internal strains due to differences of temperature. There is practically no danger from fire, as the outer walls of the furnace are never hot. In fact, when running at a temperature of 1,300 degrees Centigrade, the hand may be placed on the outside of the furnace without being burned. It is so simple and requires so little care and attention that it may be operated by an ordinary workman. The metallic salts have no effect on the composition of the steel, and the operator never comes in contact with dangerous fumes as in the cyanide bath. It is stated, also, that in efficiency and low cost of operation, it is superior to the gas furnace.

ELECTRIC CONTROLLER & MFG. CO.'S TYPE SA LIFTING MAGNETS.

The first commercial lifting magnet was designed about thirteen years ago by Mr. S. T. Wellman. The design was later improved upon by Mr. E. B. Clark, and the manufacture of lifting magnets of both the Wellman and Clark types was taken up by the Electric Controller & Mfg. Co., Cleveland, O., more than ten years ago. Magnets of the Clark type have

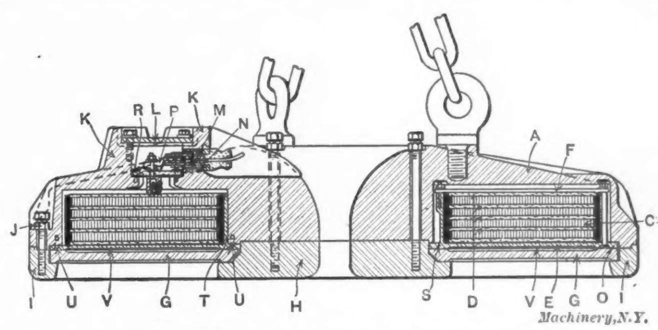


Fig. 1. Sectional View of the Type SA Lifting Magnets.

given excellent results in the handling of smooth, homogeneous material such as plates, blooms, and slabs, but are useless for handling rough and detached material such as pig-iron and scrap. Many attempts were therefore made to perfect a magnet which would handle these materials, and the first commercially successful lifting magnet of this kind was placed on the market by the Electric Controller & Mfg. Co., in March, 1905. An improvement on this magnet has now been brought out, and is shown in the accompanying line-engraving Fig. 1. This is known as the type SA magnet.

In the illustration, A is the body or frame of the magnet. This frame is an angular casting of special "electrical" steel, substantially ribbed on both its upper and outer surfaces. Besides strengthening the casting, the ribs serve to dissipate the heat. The core of the magnet is surrounded by the winding C which is composed of a series of coils each wound with a conductor in the form of a copper ribbon or strap, the turns of which are insulated with asbestos ribbon. Neighboring coils are separated and insulated by the disks D. The coils are wound on a heavy brass form E, which resembles a spool having one head removed. This form supports the coils during the winding. After the last or uppermost coil is wound and the outer disk of insulation is in place, the winding is clamped to the form by means of straps F, thus making the winding and the brass form a rigid unit. The winding is then dried under vacuum and then impregnated with a plastic insulating compound, first under vacuum and then under compressed air, and finally again dried under vacuum. This makes the winding not only fire-proof but also thoroughly water-proof. The completed winding is then placed in the magnet case.

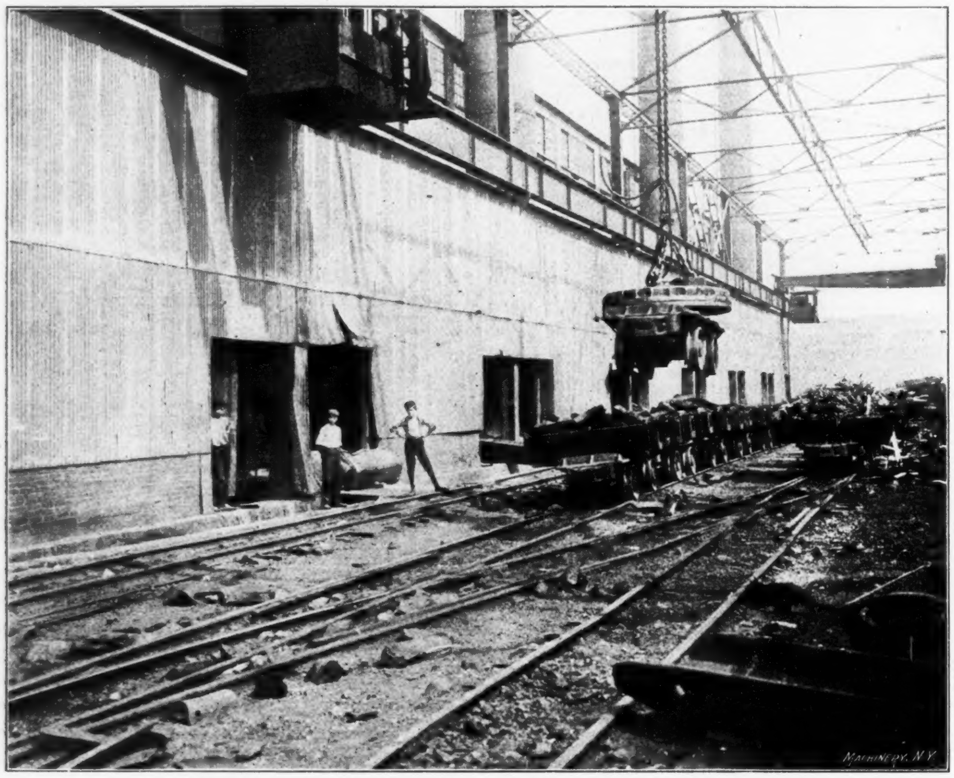


Fig. 2. Striking Example of the Capacity and Adaptability of Lifting Magnets.

It will be noted that the form E is provided with an outer flange O and an inner flange S in addition to the central flange T extending upward and supporting the winding. The inner and outer flanges are carefully finished and fitted to finished surfaces on the inner and outer pole faces of the magnet case. This seals the lower face of the winding chamber, and a water-tight joint is insured by clamping the flanges in place by the screws U which are spaced four inches apart all around the flanges O and S. This clamping arrangement, together with the clamps F already mentioned, holds the winding rigidly and prevents displacement.

With the winding thus assembled in the magnet case, the lower face of the coil form E is covered by a heavy annular plate G of non-magnetic manganese steel, which in turn is held in place by the pole shoes H and I. Both of these pole shoes are provided with shoulders, thereby protecting the bolts from shearing stress. The heads of the outer clamping bolts J are protected by the ribs of the frame between which they are located. It will be noted that the manganese steel plate G is provided with raised shoulders around its inner and outer peripheries, which provides for a seat against the magnet poles and an air space or cushion under the winding at V. By this means the shocks taken by the outer plate G will be transmitted directly to the magnet frame instead of being taken by the winding. The magnet pole shoes are so constructed with regard to the outer plate G that none of the clamping surfaces can become battered, and, if required, the plate G can therefore always be easily renewed. The entire lower wearing face of the magnet can also be renewed without difficulty at any place where the magnet may be in use, there being no necessity of exposing or disturbing the winding, or breaking the water-tight joint between the coil form E and the frame of the magnet.

The terminals in the lifting magnet shown are also of interest. The terminal cavity is surrounded by raised walls K which are cast integral with the magnet case, and of sufficient strength to withstand any stresses which may be placed

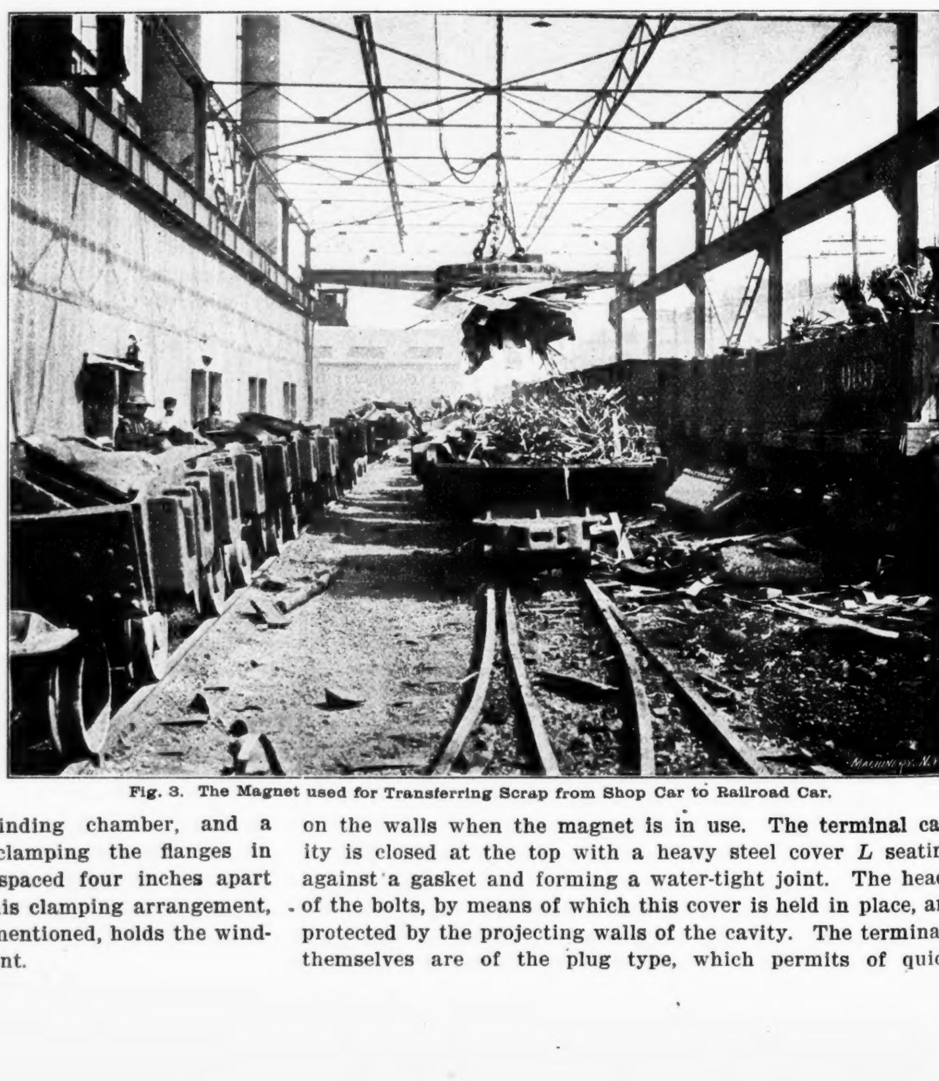


Fig. 3. The Magnet used for Transferring Scrap from Shop Car to Railroad Car.

on the walls when the magnet is in use. The terminal cavity is closed at the top with a heavy steel cover L seating against a gasket and forming a water-tight joint. The heads of the bolts, by means of which this cover is held in place, are protected by the projecting walls of the cavity. The terminals themselves are of the plug type, which permits of quick

attachment and detachment of service wires. Several improvements have been made in the details of the construction over previous designs. The female members *M* of the terminal are enclosed in an insulating tube so that a ground or short circuit cannot result even if the service wires should be left hanging from the crane with the current on. The insulating tubes are each encased in a steel tube to prevent abrasion of the insulation. These steel tubes fit closely in babbitted openings *N* in the side of the terminal chamber. The male members *P* of the plug connectors are mounted upon a heavy plate *R* of fire-proof insulating material which closes the entrance to the winding chamber and is seated upon a gasket effecting a water-tight joint. The plugs and the plate *R* may be removed without throwing any strain on the connection to the winding, the connections consisting of loops of very flexible copper ribbon, as indicated in the engraving, and placed in the box-like ends of the terminal studs. This construction makes it impossible for the flexible leads which connect to the two ends of the magnet winding to come into accidental contact.

As an example of the capacity of these lifting magnets it may be mentioned that a magnet of the new type, 40 inches in diameter, known as No. 4 type SA magnet, lifts practically the same amount as a magnet 50 inches in diameter, of the older designs, but weighs 2,000 pounds less. This means that for the same power consumption the magnet can lift a much greater load, inasmuch as the dead weight of the magnet must constantly be taken into account.

The accompanying half-tones Figs. 2 and 3 show two interesting applications of these magnets. In Fig. 2 the capacity and adaptability of the magnet is strikingly illustrated; in Fig. 3 its capacity for lifting scrap is plainly in evidence.

YEMCO QUICK-ACTING WRENCH.

Figure 1 shows a quick-acting wrench made by the York Electric & Machine Co., 30-34 N. Penn St., York, Pa.; Fig. 2 shows the method of operating it. In closing the wrench, the construction is such that the sliding jaw may be pushed freely

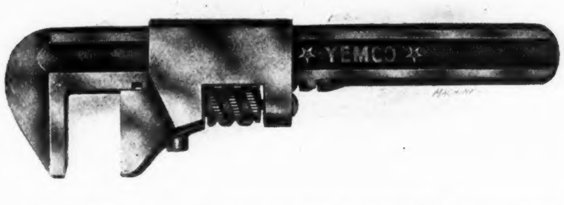


Fig. 1. Quick-acting Wrench made by the York Electric & Machine Co.

forward until it fits the nut, when it is securely locked in position. Pressure on the plunger in the sliding jaw releases it, so that it may be withdrawn from the nut and adjusted to a larger size. The operation of opening or closing may be performed with one hand.

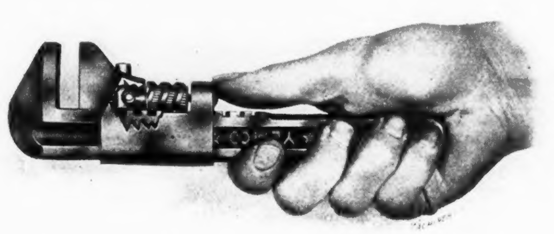


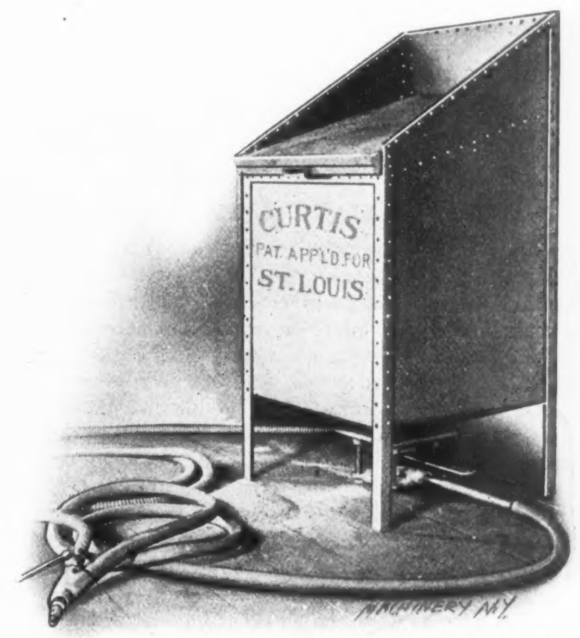
Fig. 2. Method of Operating the Quick-acting Wrench.

The construction is shown in Fig. 2. The screw is double-threaded and of steep pitch, engaging angular grooves cut in the body of the wrench; in pushing the jaw forward, this steep-pitch screw revolves freely. When reverse pressure comes on it, however, a coiled spring contained within the nut, presses it forward so that its conical front bearing is forced into its taper seat, with sufficient pressure to lock it by friction against any possible rotation from movement of the jaw. When sliding the jaw forward this screw is pushed by the pressure away from this taper seat, against the resistance of the spring, so that it is free to revolve. When it is desired to push the jaw backwards, the plunger shown is pressed. This pushes the ball against the conical bearing of the screw and forces it out of contact so that it is free to revolve and allow the jaw to be drawn back.

This wrench is eight inches long, made of a high quality of steel drop forging and is case-hardened with a mottled finish.

CURTIS SAND-BLAST OUTFIT.

The Curtis & Co. Mfg. Co., St. Louis, Mo., makes the improved form of sand blast shown herewith. It varies radically in its construction and operation from other apparatus of this kind on the market, particularly in the fact that the screening apparatus is incorporated in the design of the



A Sand Blast Apparatus in which the Supply is taken from an Open Tank.

device, and in the fact that the sand is not under pressure either in the reservoir or in the hose which leads it to the nozzle.

The reservoir or tank is open at the top, but is covered with a screen of such mesh as to allow dust and sand of the proper size to fall through, while pieces of castings or other foreign matter roll down the incline and fall through the screen. Before the sand has a chance to drop into the tank, the dust is separated from it by means of a small air jet, so that only the sand itself, of the right size, enters the hopper. In the center of the cone-shaped bottom of the tank is an opening of about hand-hole size. Underneath this is the plate shown attached by four studs. The sand drops freely through the hole onto this plate, where the cone-shaped pile thus formed stops the opening and prevents overflowing. The air and sand hose are separate, being joined only at the nozzle. The blast of air through the nozzle creates a partial vacuum in the sand hose, which draws the sand by suction from the pile on the plate at the bottom of the tank. The air supply alone is regulated, and this is done by the air valve at the nozzle in the operator's hands. The supply of sand regulates itself automatically.

Among the advantages claimed for this arrangement are the following: A complete and effective screening attachment; the possibility of filling the machine when the blast is in operation; the avoiding of the trouble from moisture in the air, accomplished by keeping the sand out of contact with the air blast until it has reached the nozzle holder; the regulation of the machine from the operator's working position; the possibility of cleaning the sand blast hose while the machine is in operation, by pressing the nozzle to the floor for a few seconds; the use of a cheap grade of sand blast hose, made possible by the fact that the sand is drawn through by suction instead of forced through by high press-

ure; and a reversible construction for the nozzles. The New York address of the builders of this apparatus is 30 Church Street.

WIZARD QUICK-CHANGE DRILL-CHUCK AND COLLET.

The McCrosky Reamer Co. of Meadville, Pa., is manufacturing the "Wizard" quick-change drill chuck and collet shown in Figs. 1 and 2. This tool is of the type which permits drills, reamers, taps, counterbores, etc., to be placed in or removed from a machine spindle without stopping it. Its special advantages lie in the firmness with which the collets are held, and the ease with which they may be inserted Special pains have also been taken to put the highest grade of material and workmanship into their construction.

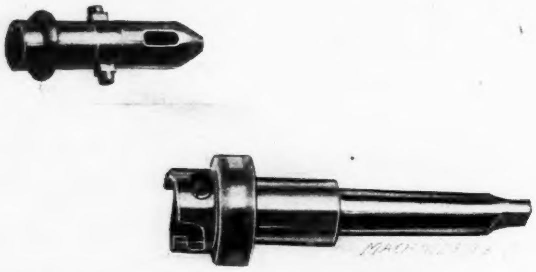


Fig. 1. The "Wizard" Quick-change Chuck and Collet.

The chuck and the collet, separated, are shown in Fig. 1. The chuck has a Morse taper shank, fitting the spindle of the machine, with a seat at the outer end to receive the collet. The latter is ground accurately on the outside diameter to fit this seat, and is provided, as well, with a conical point which assists in inserting it in the chuck, and firmly centers it after it is seated. When the collet is pushed into the chuck, as shown in Fig. 2, the driving lugs on the side of the collet ride up the inclined cam surfaces and strike against the entrance of an angle slot in the collar on the lower end of the chuck. The revolving spindle causes this collar to rotate slightly when grasped by the hand, as shown in Fig. 2, allowing the driving lugs of the collet to enter the slots in the chuck. The releasing of the hand then permits the sleeve to fly back under the influence of a spring contained within it, locking the lugs of the collet securely in place by a principle identical with the bayonet lock of the Springfield rifle. As the locking surface is made angular, the collet is forced with considerable pressure back into its seat, so that it is accurately centered by its tapered point. In releasing the collet, the collar is grasped by the hand, when the revolving of the spindle opens the lock and permits the collet to drop freely or be taken out. It will be noticed that the collets are provided with a collar, which is used against the hand as a shoulder, when placing the tools in the chuck or in catching them when released. The form of lock employed makes the chuck useful for back-facing as well as for straight drilling or counterboring.

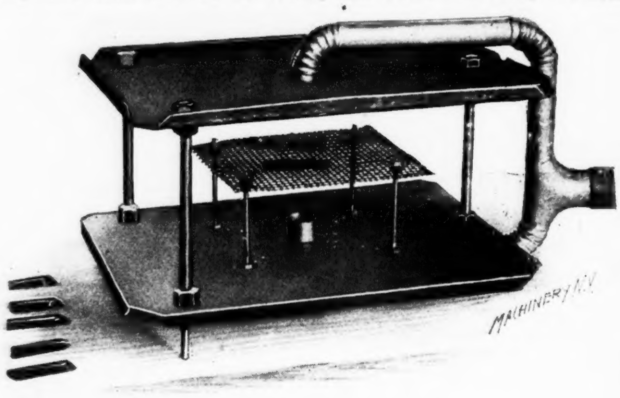
Fig. 2. Inserting a Collet in the Chuck.

These collets are drop-forged from high grade steel, machined, hardened, and ground. The whole collet, including the driving lugs, is a solid piece of steel. They are furnished either with standard Morse holes or sent blank. The blank collets are not hardened, and may easily be bored to receive straight shanked drills, taps, reamers, etc. If desired, these are sent 0.003 inch over size so that they may be hardened and ground after being fitted to the tools. Various ways of fitting special tools to these collets may be employed. One of the most convenient ways is to drive a hardened pin through both collet and tool shank. Set-screws may also be used, or a tang and drift slot may be formed in the tool shank and the collet. In all cases it is best to bore blank collets to a driving fit. The chucks are hardened and ground inside and out.

Chucks are made in three sizes, for collets 15/16 inch in diameter with a maximum hole of Morse taper No. 2 for the smallest size up, to collets 1¾ inch in diameter with Morse hole No. 4 for the largest. When required, the chucks will be sent with the shank left blank, so that they may be turned to fit the tail-stock of a lathe, or other irregular taper holes.

KRIEGER TOOL & MFG. CO.'S AIR HARDENING STAND.

The Krieger Tool & Mfg. Co., 83 West Randolph St., Chicago, Ill., has designed a stand for the air cooling of cutters in hardening. The special purpose of the arrangement is to subject the tool being hardened to a blast of air from every side, and thus harden it evenly all over. As may be seen from the engraving, the cutter to be hardened is placed on a screen. This is supported between the openings of two blast pipes, which direct the air onto it from each side. By placing on the blast pipes special top and bottom nozzles having elongated openings, it is possible to harden several objects at a time, and thus increase the capacity of the device.



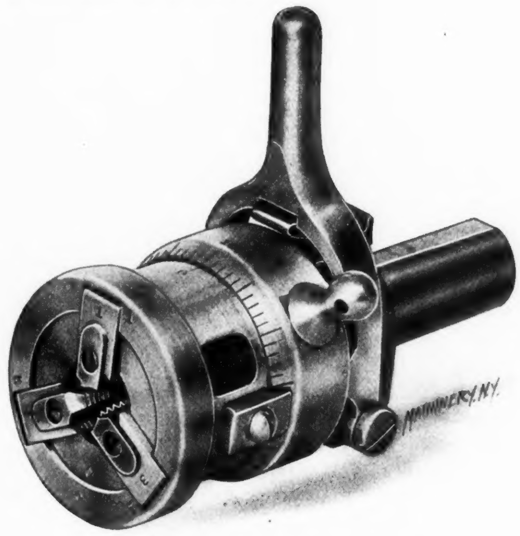
Air Cooling Stand arranged to Direct the Air Blast on all Sides of the Work.

DIAMOND AUTOMATIC DIE-HEAD.

The accompanying half-tone illustrates a new self-opening die-head brought out by the Diamond Power Specialty Co., Detroit, Mich. This die-head embodies several new features of which the four most important ones are: the arrangement for discharging the chips; the method of preventing unequal wear of the chasers; the range of the capacity of each size of head; and the relatively small size of the die-head for its capacity.

The first of these features, the discharging of the chips, is accomplished by providing ample openings back of the chasers through which the chips are flushed out by the oil used for cutting the thread. Unequal wear on the chasers is provided against by mounting them on pivots in the body of the die so that when they are drawn together by the adjusting ring, the outer end, where the heaviest wear takes place, closes in faster than the portion nearer the pivots, thus compensating for the unequal wear in the length of the chaser, and making possible the producing of threads of uni-

fcrm diameter throughout their length. This is a most important improvement in this class of dies. The construction of the die-head permits right- and left-hand threads, whether of U. S. standard shape or square, Acme, Whitworth, pipe, or special threads of various pitches to be cut with the same die-head on stock within the limits for which the head is suited simply by changing chasers. The die-head can also be used as a forming tool for small articles by using special blades of required shape. The fourth feature of this die-head, to which special attention is called, is its small size in comparison with its range. The closing ring is placed outside of the chasers, and has its bearing on the latter immediately over the point where the greatest cutting stress comes. Any wear between this closing ring and the chaser holder is taken up in adjusting the die for size, so that this wear does not accumulate with the use of the die.



A Compact Self-opening Die-head.

The length of the thread cut is adjusted closely by an internal stop-pin actuated by the work, thus enabling it to be used in an ordinary turret or automatic screw machine. When the stop-pin is removed, a thread of any desired length can be cut. For heavy, rough work, a stop can be furnished which permits taking two cuts in producing the finished thread. The die-head is closed either by hand, or by fastening a small piece of steel on the turret slide, to actuate the closing lever on the backward motion of the turret.

WALTHAM AUTOMATIC ESCAPE-WHEEL CUTTING MACHINE.

The cutting of escape wheels for watch movements requires several operations, to form the teeth accurately to their somewhat complex shape. In all except the largest watch factories, the cutting of these wheels is done on machines similar in principal to the larger automatic gear cutters used in the machine shop, excepting that a turret containing a number of spindles is used instead of the single spindle found in the larger tool. In the commercial form of automatic wheel cutter, this turret is indexed by hand after each cut around the work. Some of the largest watch factories have designed machines of their own which index automatically, not stopping until the entire cutting has been accomplished. These machines, however, are not on the market. The Waltham Machine Works, Newton St., Waltham, Mass., has recently produced the machine shown in Figs. 1 and 2, which is entirely automatic in its action and is built for sale to the trade generally.

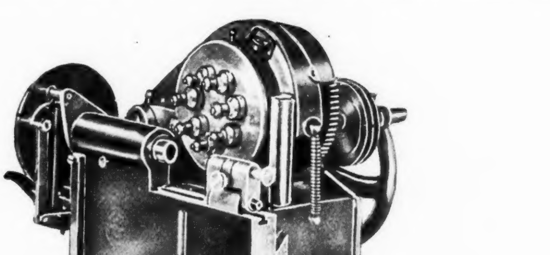


Fig. 1 Automatic Machine for Cutting Escape Wheels for Watches.

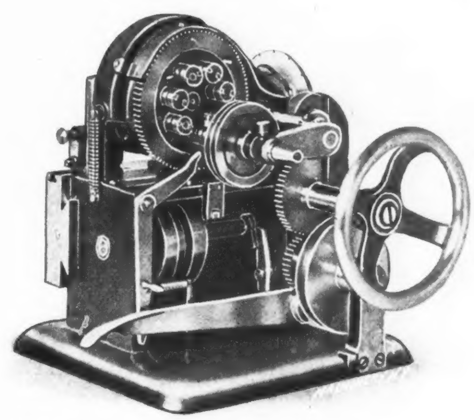


Fig. 2. View showing Mechanism within the Base.

The base of the machine encloses the cam mechanism which governs its movements, as shown in the illustration Fig. 2. On the base is mounted a spindle turret, of cylindrical form, containing, in this case, seven spindles (less than seven spindles may be used in cutting shapes of wheels in which so many cuts are not required). In operation the machine takes the first cut around the wheel, indexing automatically, step by step. When the last tooth has been cut, the drive is disconnected from the cam-shaft, and engaged with the turret spindle revolving mechanism. When the turret has been indexed to a new position, the feed is again connected, when the second cut proceeds as did the first one. The last time around, at the completion of the last cut, the machine is stopped.

The spindle head swings upward about its pivot on the return stroke of the work and the indexing of the latter takes place during this movement. The periphery of the cylinder which carries the spindles, carries also a series of adjusted screws for regulating the depth of cut for each cutter. For longitudinal position, each cutter is adjusted by turning the threaded quills that serve as bearings for the spindles. Each cut is thus independently adjusted. A swing feed stop is provided for supporting the work arbor. The index mechanism is of the standard form used by this firm.

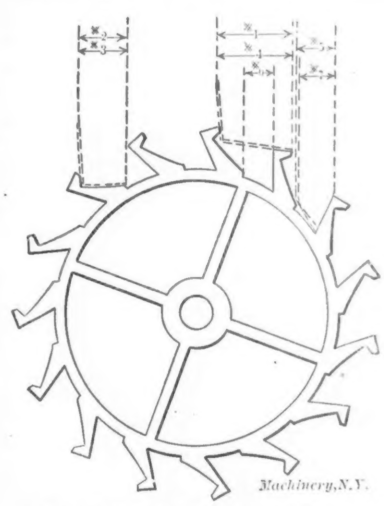


Fig. 3. Shape of the Teeth and Layout of the Cutting.

Fig. 3 shows the shape of teeth produced and the layout of the cutting. It will be noted that there are in this case fifteen teeth, and that seven cuts are required to complete each tooth, making 105 cuts in all. As explained, this is done entirely automatically, and the machine stops at the completion of the 105th cut.

ARMSTRONG KNURLING TOOL.

The knurling tool shown in the accompanying illustration is made by the Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. Its construction is evident from a glance

at the illustration. Exclusive of the rolls and pins, it is composed of but two parts—the shank, and the rocking holder for the rolls. The holder fits into a tongued and grooved circular seat in the shank, being retained in place there by a pin passing through a circular groove in the tongue formed on the shank. The holder is thus free to swivel when brought

Armstrong Knurling Tool of Simple and Rigid Design.

in contact with the work, so that both of the rolls bear on the metal with even pressure. This method of self-centering gives practically no lost motion, and the joint has ample bearing to resist the strains of both end and side thrust.

This tool is furnished with either coarse, medium or fine knurls. The knurls and pins are made of hardened tool steel. The other parts are drop forged or bar steel, hardened.

NEW LINE OF POOLE BORING AND TURNING MILLS.

The J. Morton Poole Co., Wilmington, Del., has designed a new line of boring mills for sizes from 7 to 14 feet swing. The accompanying illustrations show the general features of this new line. It is intended to meet the requirements of general shop use. The various sizes are liberal in their dimensions, and are carefully designed as to distribution of metal and weight to give the maximum efficiency at high speed. The journals and bearings are carefully scraped;

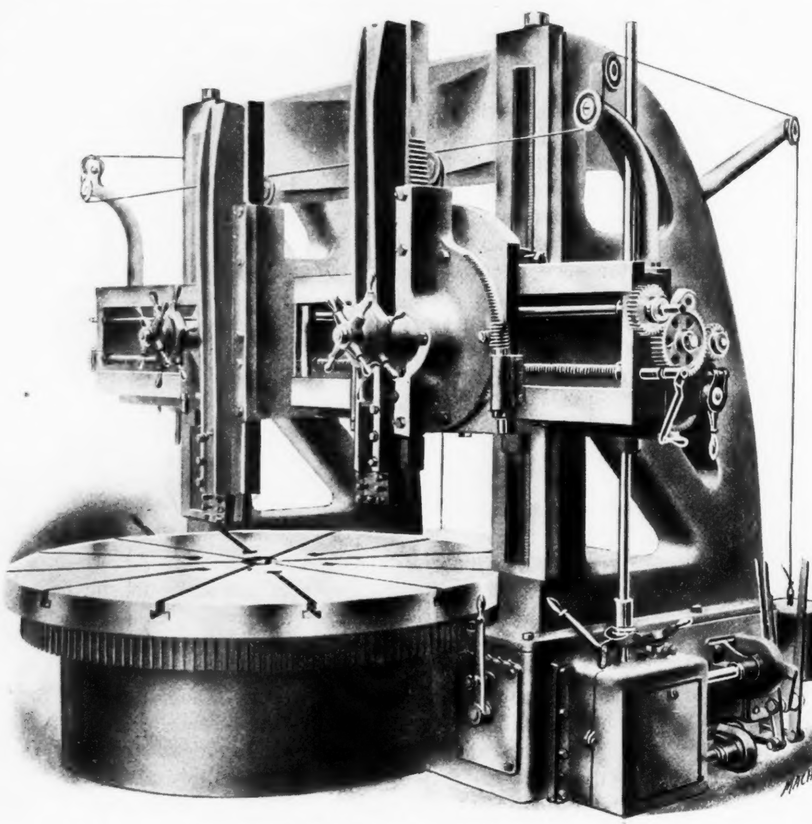


Fig. 1. Poole Boring and Turning Mill, 7 to 14 feet Swing.

bronze gears and bushings are used throughout wherever necessary. A particular point is made of ease of operation, all rapid movements being effected by power, insuring rapid production of work.

A general view of one of these machines is shown in Fig. 1. It will be seen that the bed is unusually deep; it is of box construction, and is braced with internal ribs to give the required stiffness. The uprights are securely bolted to the bed, and are properly dowelled and connected by a stiff cross base. The cross rail housings and top brace can be removed from the machine, when a sweep can be attached to the table for boring large castings. Under these conditions there is no part of the machine projecting within the travel of the sweep, thus adapting it, particularly, for such work.

The drive of the machine is best seen in Fig. 2, which shows the back gearing with the cover removed. The 3-step cone shown is connected by a silent chain with the driving

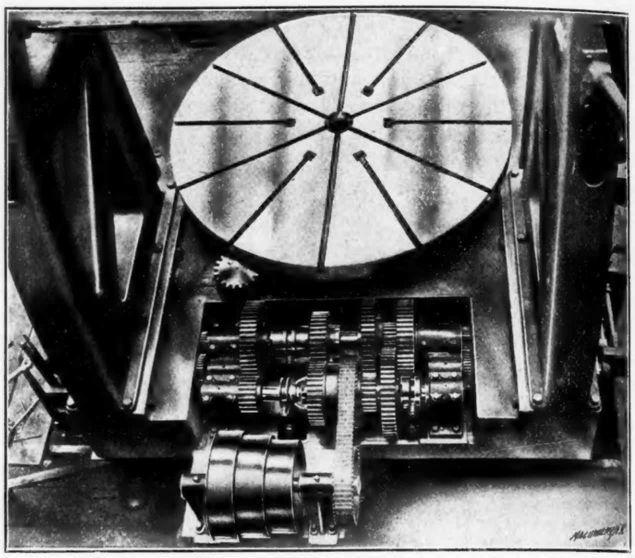


Fig. 2. Looking Down on Gear Drive from the Rear.

shaft of the back gearing. This latter, by means of positive and friction clutches, gives four changes of speed. This, with the three-step cone and two-speed counter-shaft, gives 24 table speeds in all. It will be noted that the back gear shafts are not journaled in the sides of the bed, but are set in pedestal bearings, whose caps may be removed, thus permitting the removal of the entire gearing without dismantling the mill. All the gearing at the back of the machine is well protected with a heavy gear cover, which may be easily removed. For electrical drive, the cone pulley shown is replaced with a motor, which is connected to the driving shaft in the same way by a silent chain. By using a motor having a variable speed ratio of 2 to 1, the full range of speeds given by the belt drive is obtained, but with finer gradations.

All the gearing is of steel, except the table gear and the driving pinion, the latter of which has 20 teeth. These are both made of a high-grade, close-grained cast iron, especially adapted for the gearing. They will be furnished with steel at an extra cost, if desired. The table is driven on a very large diameter, giving adequate power up to the full range of the machine. The table spindle is accurately finished by grinding on dead centers. It is carried in two bearings of large diameter, provided with taper bushings and adjusting screws to take up the wear. The lower bearing is supported in the bed by a heavy bonnet. Owing to the depth of the bed, the bearings can be placed far enough apart to insure stability.

The cross rail is of box girder form and of large cross section, circular in the center. It is held in position by clamps on the inside and outside edges of the uprights. It is raised and lowered by a power traverse, the mechanism of which is very simple, and is located within the bed, thus

adding to the neat appearance of the machine. The power traverse is also applied, in this machine, to the cross-heads and tool bars as well, which are handled by power in either direction, thus saving a great deal of time and labor. The

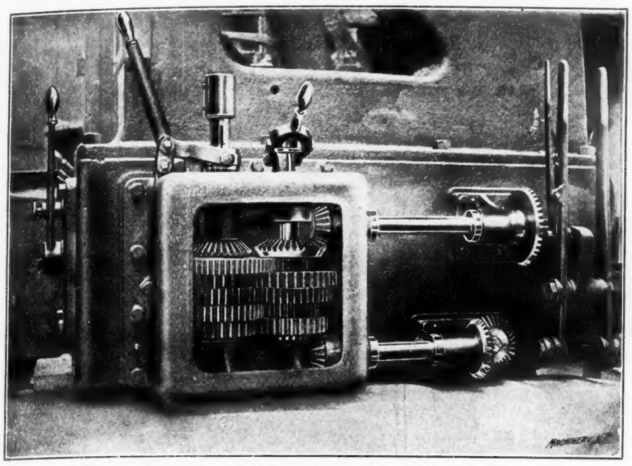


Fig. 3. Feed-box of the Poole Boring and Turning Mill.

rapid traverse shaft is driven by spur gearing from the intermediate back-gear shaft in both the motor- and belt-driven machines. It is impossible to throw in both the traverse and slow feed at the same time.

The cross-heads are entirely independent in their movements as to direction and amount of feed; each one can be brought to the center for boring. The rams are very stiff and are separately counterbalanced by weights at each end of the rail. The counterbalance weight is connected at the rear of the frame, thus providing room for chains from overhead cranes. Each head is equipped with a forged steel square tool bar, secured by three binding screws and a set-screw. By the operation of the swivel worm, the heads can be set at any angle up to 50 degrees in either direction. Eight feeds are provided for each head, ranging from 1/40 inch to 1 inch per revolution of the table. Fig. 3 shows the feed box (there is one on each side of the table) with the cover removed. The eight changes are obtained in this box without stopping the mill. The feeds of the two heads are entirely independent. The gears are of cast iron and bronze, of coarse pitch and wide face, strong enough for the heaviest work they will ever be called on to perform.

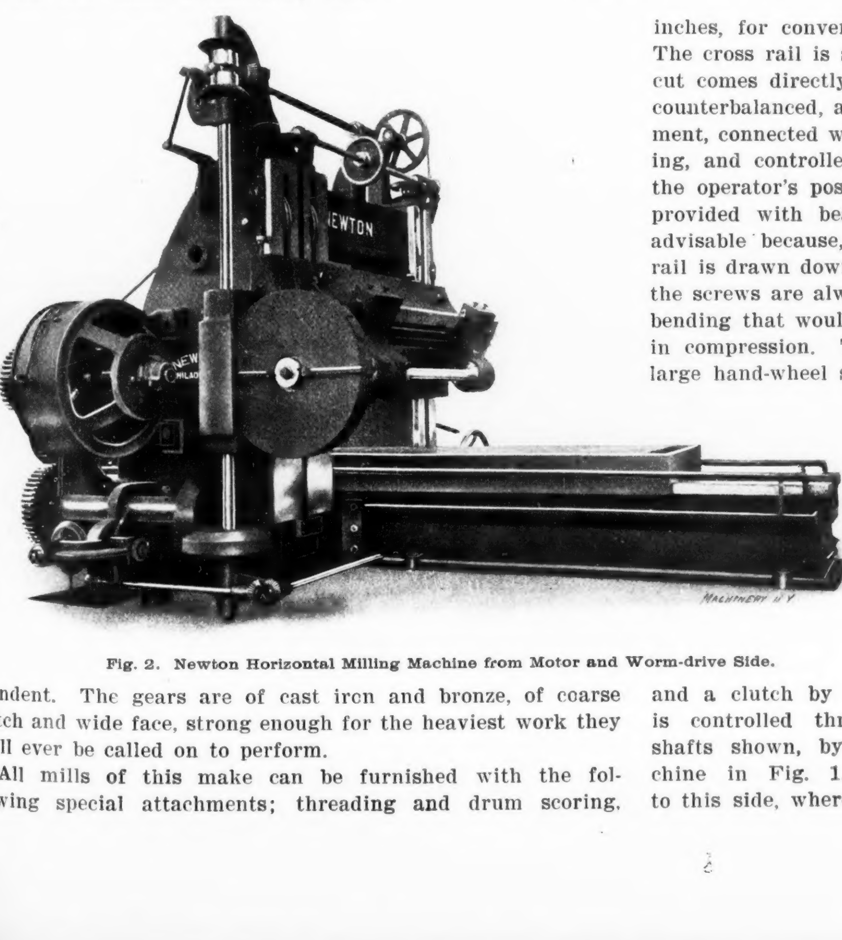


Fig. 2. Newton Horizontal Milling Machine from Motor and Worm-drive Side.

All mills of this make can be furnished with the following special attachments; threading and drum scoring, key-seating, and slotting, traveling or stationary head with revolving spindle, and special heads with various styles of tool bars for special work.

THE NEWTON NO. 7 HORIZONTAL MILLING MACHINE.

Figs. 1 and 2 illustrate the latest and heaviest designs of plain milling machines built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. It is provided with the builders' latest arrangements of feed and speed control, in which all the operating handles are located on the working side of the machine, as shown in Fig. 1. The machine is intended for the heaviest kind of slab milling.

The spindle is driven, as shown in Fig. 2, by a 50 H.P. motor, which is connected by spur and bevel gears with the splined vertical shaft, mounted on the left-hand housing. This shaft drives a hardened steel worm of very steep pitch, engaging a bronze worm-wheel keyed to the spindle, and running in oil. The spindle of this machine is 8¼ inches in diameter, and has a cross adjustment along the rail of 12

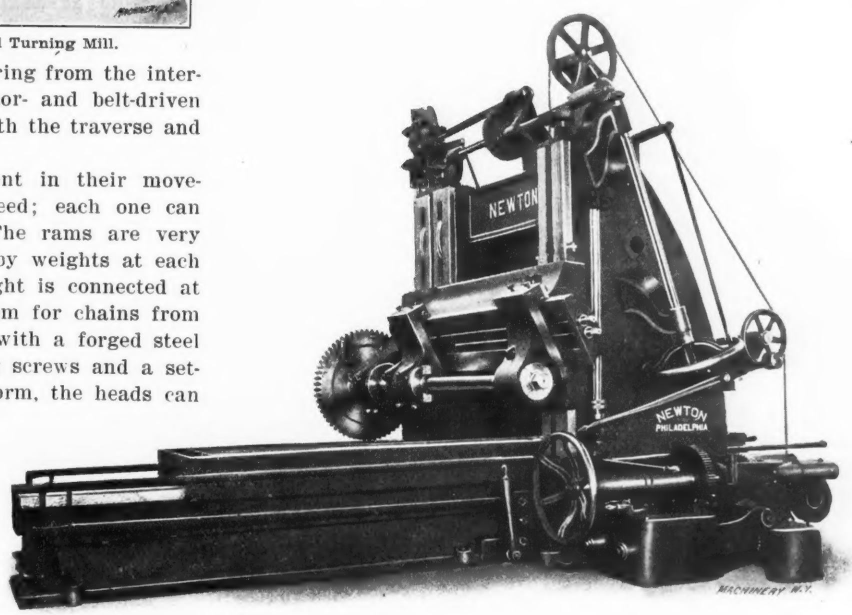


Fig. 1. Newton Horizontal Milling Machine from Operator's Side.

inches, for convenience in setting the cutters to the work. The cross rail is set at such an angle that the thrust of the cut comes directly against the broad bearing surface. It is counterbalanced, and is provided with a rapid traverse movement, connected with the vertical shaft on the left-hand housing, and controlled by the counter-weighted lever shown at the operator's position in Fig. 1. The elevating screws are provided with bearings at both top and bottom. This is advisable because, in forcing the cutter into the work, the rail is drawn downward and by placing bearings at each end the screws are always in tension. This avoids the danger of bending that would otherwise result from having the screws in compression. The hand adjustment is by means of the large hand-wheel shown on the angular shaft in Fig. 1. At the side of the housing in this engraving will be noted a threaded rod with four adjustable collars (only two shown) for determining the vertical position of the rail for duplicating depths of cuts in manufacturing work.

The power for the feeds is taken, as shown in Fig. 2, from the horizontal driving shaft at the base of the housing, through bevel gears and a clutch by which the shaft is reversed. This clutch is controlled through the small bevel gears and rock shafts shown, by a lever on the operator's side of machine in Fig. 1. The feed shaft drive comes through to this side, where it may be connected with the feed shaft,

either directly at a high speed ratio for the rapid movements of the table, or through the feed change box shown, which gives nine rates of feed by the manipulation of the two handles provided. This change from rapid traverse to power feed is effected by a lever conveniently placed, which also serves to lock the table in position when set centrally, with the feed thrown out. This locking is convenient when cutting down into the work. The table is fed through a spiral gear and rack. Hand adjustment is obtained by the large hand-wheel shown on the horizontal shaft in Fig. 1.

The work table of this machine is 42 inches wide, and will mill 8 feet in length. The distance between the uprights, and the distance from the center of the floor to the top of the work table is 50 inches. The approximate net weight of the machine is 96,000 pounds.

NEWTON HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

Figs. 1 and 2 show two views of a horizontal boring, drilling and milling machine built by the Newton Machine Tool Co., Inc., Philadelphia, Pa., for the Japanese government. These machines are interesting because of their range of capacity and the completeness of the speed, feed and rapid traverse movements incorporated. Particular attention has also been paid to bringing the various controlling handles within reach of the operator.

The machine is driven by a 7½ H.P. motor, with a speed ratio of 3 to 1. This motor is mounted on the left of the machine, and is best seen in Fig. 1. The power is transmitted from this through raw hide and steel spur gears, splined shafts and bevel gearing, to a driving shaft in the head, parallel with and above the spindle. This connection is made through a bevel gear reversing device, seen in Fig. 1, operated by a handle near the front end of the spindle, within convenient reach of the operator. The driving shaft may be

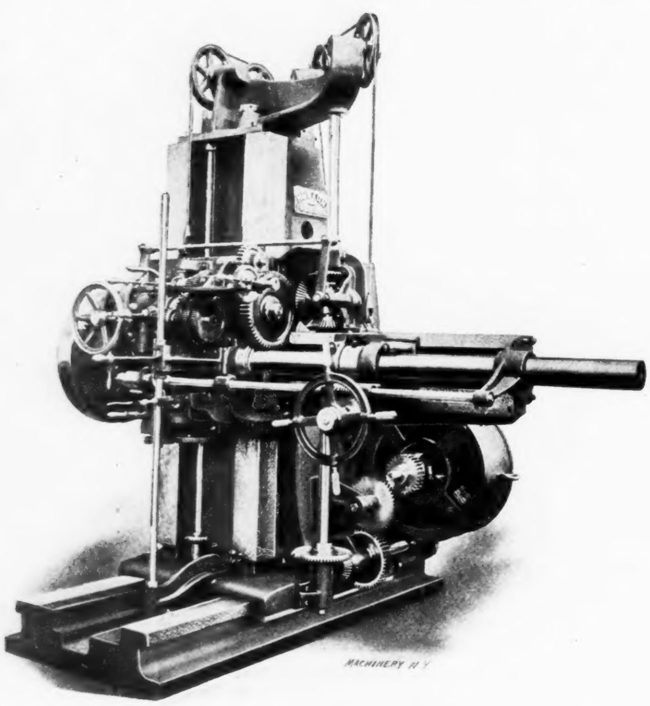


Fig. 1. Newton Horizontal Boring, Drilling and Milling Machine.

set to drive the face-plate directly through the internal gear, or, for high speeds, by a longitudinal shifting of the driving shaft; the spur gear keyed to it may be engaged with a similar gear keyed to the spindle. For the face-plate drive, the pinion is cut from the solid metal of the shaft. The speed range is from 10.44 to 31.44 revolutions per minute for the face-plate drive, and from 33.75 to 101.25 revolutions per minute for the high-speed connection.

The feeds are taken from the driving shaft, through the nest of gears shown. The feed operates through a bevel gear reversing mechanism which applies to all the feed movements in the machine. The hand-wheel on the heads gives a fine adjustment for all the machine settings. At this station the manipulation of suitable levers applies the feed either to the longitudinal traverse of the bar, the vertical traverse of the head, or the horizontal traverse of the column on the bed. The traverse of the column on the bed is effected by a spiral rack and pinion movement. In this case, the handles for throwing in the rapid movement and the power feed, interlock with each other, so that the simultaneous application of both is impossible. All the rapid

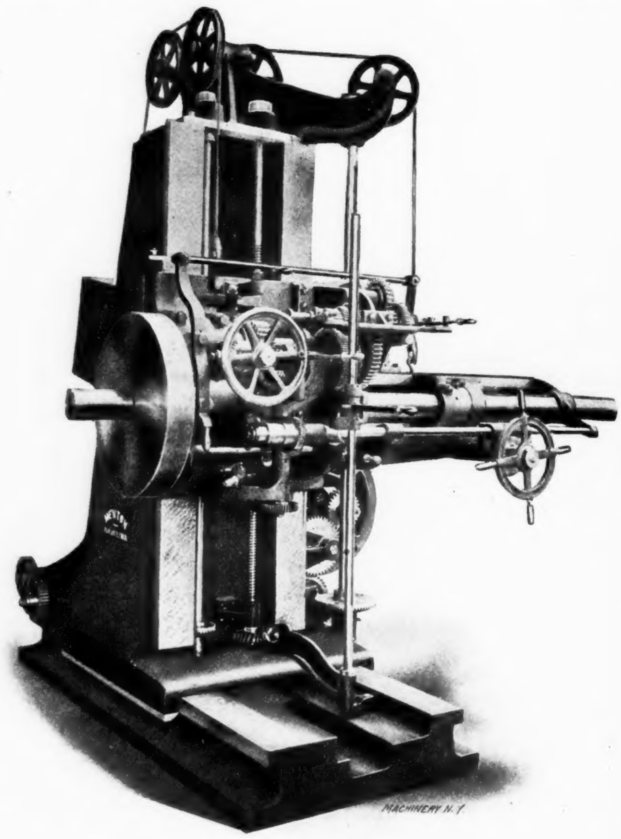


Fig. 2. Newton Horizontal Boring, Drilling and Milling Machine.

movements are derived from the horizontal shaft shown below the motor in Fig. 1. The rapid movement of the spindle is by hand, through the wheel shown in the extreme right of Fig. 2. With the construction of spindle feed slide provided, the length of the bar and the length of its traverse can be increased to any amount required by the work of the purchaser.

The spindle of this machine can be adjusted from 20 inches to 60 inches above the floor plate. The upright in this particular case has a horizontal movement of 4 feet, although this can be increased if desired. The face-plate of the machine is 28 inches in diameter over all. The spindle is 4½ inches in diameter and has a continuous power feed 32 inches in length; it is provided with a No. 6 Morse taper.

THE NEW BRITAIN MACHINE CO.'S POLISHING FRAME.

The polishing frame shown herewith is built by the New Britain Machine Co., New Britain, Conn., for those who prefer the form in which the spindles run in conical bearings in maple blocks. The frame is a large section, with a suitable amount of overhang, allowing tubes, cylinders, hollow ware and irregular shapes to be finished without the interference met with where straight frames are used. The weight is sufficient to avoid trouble from vibration. The base, while giving a large supporting area, is narrow and does not obstruct the work of cleaning up or sweeping the floor.

The frames are bored to take wood blocks two inches in diameter. The adjustment of these blocks is locked by set-screws, which do not, however, bear directly on the wood. Each of these set-screws is provided with a swiveling, drop

forged handle, which is always in place and may be swung out of the way so as to not interfere with the work. The belt may be led from an overhead or a rear countershaft, as desired.

The height of this machine from the center of the spindle to the floor is 32 inches; the length of arbor used is about

A Polishing Frame for Wood-centered Spindles.

12 inches; and the shipping weight is 250 pounds. The arbor is not regularly furnished, but any form suitable to the customer's work will be supplied at extra cost.

SLOCOMB REFERENCE DISKS.

The J. T. Slocomb Co. of Providence, R. I., is now furnishing reference disks similar to those used for testing micrometers, but arranged in sets for general use. The set shown in the illustration ranges by sixteenths from one-quarter inch to two inches. The disks are provided with handles for convenience in using; the quarter inch and five-sixteenths sizes are made in one piece with their handles, while those for the other sizes are detachable.

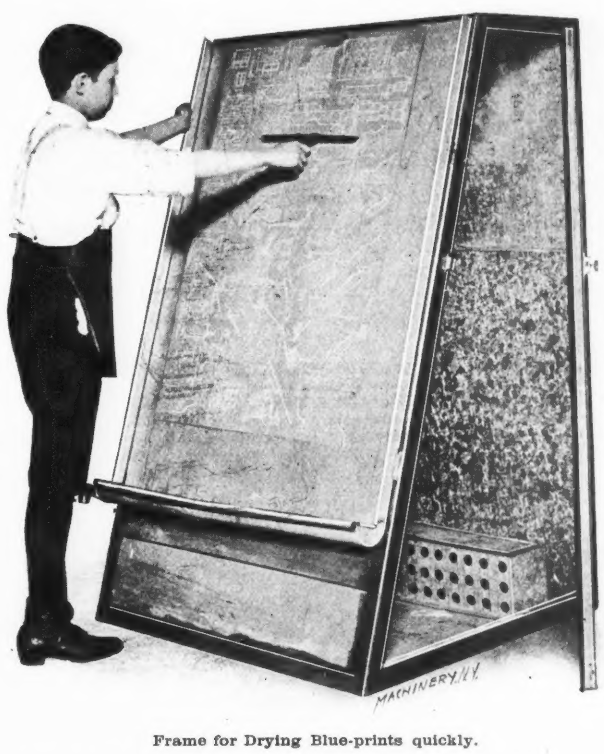
Set of Slocomb Reference Disks for General Use.

These disks are made of a good quality of tool steel, hardened very hard, and properly seasoned before finishing. This finishing is done with a high degree of accuracy. They are also made with considerable thickness to give them durability. Each of them is marked with the common fraction and decimal equivalent for the size, in such a manner that the dimensions are plainly see when the cone is open. The plugs on which they are placed are also numbered to correspond. The whole outfit regularly comes, as shown, in a serviceable morocco case, though the disks will be furnished singly, if desired.

WILLIAMS, BROWN & EARLE BLUE-PRINT DRYING FRAME.

The accompanying illustration shows an arrangement for drying blue-prints, made by Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. The difficulty of obtaining the blue-prints quickly is one that is of common occurence, and has been met by all draftsmen. Where a print is required for immediate use, it is almost impossible to dry it quickly in the old-fashioned way, by hanging it on a line and allowing it to drip onto the floor or into a sink, especially if the air of the room is saturated with water. This device saves half the time in drying, and gives the further advantage of drying the prints flat, leaving them in the best possible condition for use.

As may be seen, the apparatus consists of an inclined tray, with a draining trough at the bottom. The blue-print is spread on the back of this tray, where the extra water is removed by the rubber scraper, as shown, which also flattens



Frame for Drying Blue-prints quickly.

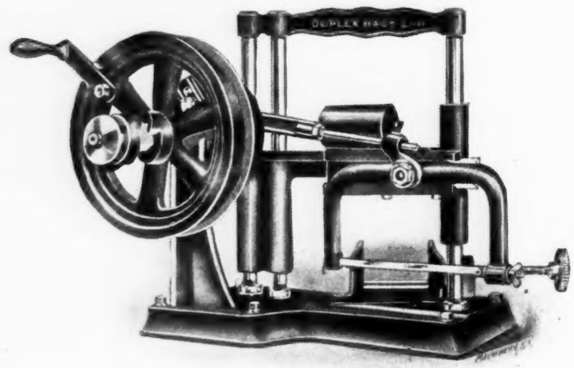
it against the back of the frame. The tray at the bottom can be connected with a drain pipe, or the water can be drained off into a bucket, thus keeping the floor perfectly dry. The arrangement shown has a drying box equipped with a heater for either artificial or natural gas. It can also be furnished without the heater, and with any desired size of tray.

BUFFALO SPECIALTY CO.'S DUPLEX HACK-SAW.

The hack-saw shown herewith is built by the Buffalo Specialty Co., Buffalo, N. Y. It is unusual in that it is designed to be used either by hand or by power. It may be placed on the work bench, where it will take up no more room than the ordinary bench vise. It is thus adapted for use in garages, stock-rooms, tool-rooms, steamship engine-rooms, round-houses, and bicycle and other repair shops.

As a hand machine, it is much easier to operate than a hand hack-saw, owing to the fact that the momentum of the fly-wheel tends to steady the movement, and owing to the fact also that the hand does not have to guide the hack-saw frame. The slide bearing on which the arm operates is made

of such proportions as to insure accurate alignment and durability, thus reducing the breaking of saw blades. This bearing is adjustable to allow wear to be easily and quickly taken up. The connecting-rod is adjustable, permitting saw blades to be used their entire length; the stroke is also adjustable to permit the sawing of large work, it being possible to set it



A Small Hack-saw adapted to either Hand or Power Drive.

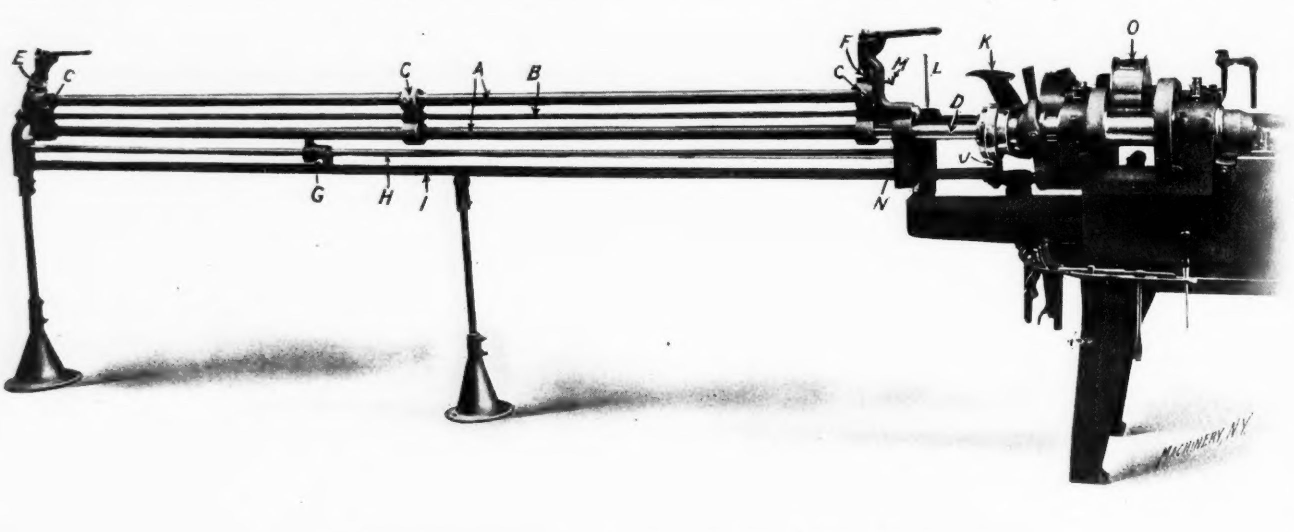
for any stroke between 3 and 5 inches. The capacity of the machine is for stock up to 4 inches square. The length of the saw blade used is 9 inches. The speed, when power-driven, should be from 85 to 100 revolutions per minute. The net weight of the machine is 80 pounds.

MAGAZINE ATTACHMENT FOR CLEVELAND AUTOMATIC SCREW MACHINE.

The Cleveland Automatic Machine Co., Cleveland, Ohio, has recently designed a magazine attachment for use with its automatic screw machines, which is adapted to using material that hitherto could only be used at a considerable loss of time. That is to say, it may be employed for feeding, automatically, to the machine irregular lengths of stock, such as short ends of bars, tubing, pipe, etc. The machine will work these up into screw machine parts, cutting them off to exact length and discarding all that will not finish out. It handles, also, anything that is nearly parallel, such as castings and drop forgings. It is made double, so that one of the holding tubes can be filled while the other is in operation, thus involving no loss of time in stopping the machine. Another important feature is the fact that it can be attached to any of the builder's plain machines without requiring it to be rebuilt.

The magazine consists of a revolving barrel composed of two steel tubes *A*, mounted on a shaft *B*, by means of three castings *C*. The lower tube is in line with the spindle of the machine and meets a tube *D* of similar size which extends through the spindle and reaches to the rear of the chuck jaws. These two tubes *A* may be revolved about the bearings in the extensions of shaft *B*, so as to bring one or the other of them in line with the spindle, when they may be locked in position by means of the two plungers *E* and *F*, seen at each end of the tubes in the photograph. These plungers may be drawn out by means of the horizontal handles shown above them. Underneath the lower tube *A* is a carrier *G*, which is free to slide on the fixed shaft *H*. Directly underneath this carrier will be seen the rack *I* which has saw-shaped teeth milled the full length of the upper edge. This rack is reciprocated by the feed lever *J* to which it is attached, this lever being operated by the regular stock feed cam which is a part of the machine. The ratchet teeth of this rack, as it is reciprocated, engage a pawl in carrier *G* and move it forward step by step, pushing the short bars of stock or individual castings through the tube and the spindle and into the chuck, one after another, as fast as the work is done. The rod *L* is an automatic stop for the machine, which is actuated by carrier *G* when this has reached its extreme forward position.

A special spindle drive is used on the particular machine illustrated, the particular features of which are a wide belt and a powerful drive through differential gearing enclosed in driving pulley *O*, which drive is thrown into action for the threading operation. When the machine is on the cutting operation, the rear train of spindle gears is used, giving a fast speed for cutting off. This change is controlled by a sliding gear arrangement operated by a lever at the rear of the spindle head.



Automatic Screw Machine fitted up for Using Short Bars of Stock, Castings, etc.

Time Recorder, made by E. Howard Time Recorder Co. This recorder is driven by a Howard clock movement, in which the record is made on a flat sheet by stamps controlled by an arm swinging around a numbered dial.

A Loose Pulley Oil Cup, made by the Lawson Mfg. Co., Buffalo, N. Y., employs the novel plan of using the centrifugal effect of a loose piston in the oil cup to force the oil into the journal of the pulley.

A Sheet Metal Punch for general shop use on light work has been brought out by the Queen City Punch & Shear Co., Cincinnati, Ohio. This is a quick-acting punch with a narrow jaw, to permit handling light work.

An Automatic Wire Cutter which will handle brass, iron or steel wire up to 7/16 inch in diameter, is built by the Narragansett Machine Co., Providence, R. I. It will cut off lengths of wire up to 2 feet at the rate of 260 per minute.

A New Pressure Blower has been placed on the market by the Natural Power Co. of St. Louis. The particular feature of this blower is the design of the runner, which gives, it is claimed, a high-pressure with a very low rotative speed.

An Alternating Current Motor Brake has been developed by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. This

brake is held open by an electro-magnet and is closed by springs, though the braking force is increased by the rotation of the brake drum itself.

A Portable Milling Machine for truing up the pedestal bearings of car truck frames is built by H. B. Underwood & Co. (Flanders Machine Works), 1024 Hamilton St., Philadelphia, Pa. While adapted to this special work, it is also applicable to general portable milling.

A Multiple Hand Punch, for piercing a number of holes at once, is made by the Lansing Machine Co., Lansing, Mich. This tool will easily pierce 24 holes in No. 16 gage sheet steel. The surface of the die is so shaped that only four of the punches are working at once.

A Motor-Driven Speed Lathe, made by the American Wood Working Machinery Co., Rochester, N. Y., has a General Electric motor mounted directly on the spindle as a part of the head-stock. The carriage is provided with a rack feed on the bed, and has a cross slide and compound rest.

The "G. M." Screw-Cutting Engine Lathe has been placed on the market by the G. M. Lathe Co., Lennox Bldg., Cleveland, Ohio. It is intended to fill the demand for a low-priced lathe for automobile garages, jobbing machine shops, etc. It is driven by a five-step cone pulley, and swings 16¼ inches over the shears.

A Power Hack-saw Machine built by Henry G. Thompson & Son Co., New Haven, Conn., introduces the feature of a positive lift and a quick return on the back stroke. The machine is intended for use on 10-, 11-, or 12-inch blades, and will operate on stock up to 5 inches in diameter. An automatic stop is provided.

A Cam-Cutting Machine has been brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. It has a large capacity, being able to cut cams up to 36 inches in diameter of face, edge, disk, or cylinder types. It resembles in its construction a profiling machine, provided with special appliances for holding the work and the master cam.

A Heavy Drilling Vise is made by the Titus Machine Works of Marion, Ohio. It is similar to that built by the same firm and described in the department of "New Machinery and Tools" in the July, 1907, issue of Machinery, but is made much heavier, so that it is useful for milling machine and planer work as well as for the drill press.

An Emery Wheel Stand with a Skeleton Frame, built of castings and steel rods, is made by George E. Soper, Kankakee, Ill. The spindle is arranged to be belted directly with the line shaft, the spindle being started or stopped by raising or lowering the head on which it is mounted in a manner somewhat similar to that followed in some designs of buffing wheel stands.

A line of Shaft Turning, Straightening and Polishing Machinery of the continuous type has recently been brought out by the Brightman Mfg. Co., Shelby, Ohio. Material as short as 8 feet in length can be machined. The apparatus consists of two machines, the first of which turns the stationary shafting, while in the second it is finished by being passed between straightening and polishing rolls.

The Magnetic Chuck, built by O. S. Walker & Co., Worcester, Mass., has recently been adapted to holding very small work. This has been done by cutting the serrated pole faces of the magnet with finer teeth, thus giving a greater number of magnetic gaps in the length of the face. Special templets may be employed for centering the work over the gap in the pole faces.

An Electric Operation Recorder is made by the Bristol Co. of Waterbury, Conn., for recording the occurrence and duration of different operations such as the starting and stopping of machines, opening and closing of valves, the passing of trains, etc. Each instrument may be furnished with as many as twelve recording pens. The paper dial used gives a complete record for twenty-four hours.

The "Stuyvesant" Turret Lathe is the name given to a new product of the J. G. Blount Co., Everett, Mass. This lathe is intended for the general run of chucking and turret lathe work in the machine shop. The ways are of the flat type; another noticeable feature of the design is the fact that the cone is reversed from the usual position, having a small step in the front.

A Double-Spindle Drilling Machine built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., employs a cross-rail with two complete spindle-heads adjustable on it. This cross-rail is mounted on two housings which, in turn, support a work table 20 inches wide by 6 feet 5 inches long. There are four belt speeds. The back gears double this number for each spindle.

The Carr Tool Holder, built by Carr Bros. of Syracuse, N. Y., and described in the new tools department of the November, 1907, issue of Machinery, has recently been improved by the provision of arrangement for adjusting the height of the tool post without losing any of the rigidity that characterizes the older form. It has also been adapted to the use of turning and boring tools, as well as side tools.

An Automatic Nut Tapping Machine of the type in which the tap floats freely, and is centered and held from revolving by the stream of nuts passing over its shank, has been designed by Mr. W. M. McKenzie, 39 Park Place, New Rochelle, N. Y. With this style of nut machine the process of tapping is a continuous one, it not being necessary to remove the tap to empty the nuts from the shank.

A Direct Process for Copying Blueprints is being introduced in the United States by Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. This, which is known as the "Duplico" process, consists in brushing a solution over the blueprint, washing it, dipping it in a second solution, again washing, and, after drying, making it translucent by a third solution. This gives a negative from which prints can be made on any kind of sensitized paper.

A Hot Pressed Nut Machine, built by the Acme Machinery Co., Cleveland, Ohio, has been specially designed for the most severe working conditions and for the utmost durability and freedom from repairs. The bed is a single steel casting. The gearing is of steel, as are all the working parts, the bearing surfaces being of hardened tool steel and phosphor bronze, with cast iron lining strips, plates and bushings. Radical improvements in the mechanism have been introduced also.

A Tool-Holder for Turning Locomotive Tires has been brought out by the G. R. Lang Co., Meadville, Pa. The blade is of the straight, forming tool variety, and is held in a dovetail seat in the holder, which grasps it firmly on the sides. Notches cut in the back of the blade engage the clamping bolt in such a way as to give a positive backing for the thrust of the cut. The holder is of course useful for holding tools of other shapes, besides those employed in railroad shops.

A Thermo-Electric Pyrometer, made by the Wilson-Mauelen Co., 1 East 42d St., New York, has been equipped by its builders with an electrical alarm attachment which rings the bell when the temperature indicated passes the prescribed maximum and minimum limits. It can be quickly adjusted for any desired limits. Another device brought out by the makers provides for shifting the connections automatically to give an indication from different furnaces successively, at intervals of a few minutes apart.

A Grinding Attachment, known as the "Marvel," built by Armstrong Blum Mfg. Co., 113 N. Francisco Ave., Chicago, Ill., is arranged to be attached to the lathe or planer without

requiring any change in the over-head works. The drum for driving the grinding wheel on the carriage of the lathe or the slide of the planer, is carried by removable supports attached to the machine itself. In the case of the lathe, this drum counter-shaft is driven from the large step of the cone pulley.

A New Line of Tool-Holders has been brought out by the Clifford Tool Co., Concord, N. H. The holders are made entirely of tool steel, so that they are not injured by the severest clamping strains to which they may be subjected. They are made in both straight and off-set styles. A valuable feature of their construction is the fact that the blades can be used until they have been ground very short, thus making the holders very economical in the use of costly high-speed steel.

A Combination Wheel and Disk Grinder, built by the Garvin Machine Co., Spring and Varick Sts., New York, is made along novel lines. The frame is of the milling machine type. The work table is oscillated by a worm-driven crank in the countershaft. The rear end of the spindle carries an emery-wheel for general purpose grinding. The emery disks furnished are provided with a gummed solution spread on them, which merely has to be moistened before application to the plate, no press being necessary.

A Horizontal Bulldozer is made by Logemann Bros., Milwaukee, Wis., which may be converted into a horizontal crank riveter. When so arranged, it is provided with a hydraulic holder-on, operated by an accumulator provided with the machine, which holds the work against the die with a certain definite pressure, but still allows the holder to recede when the stock is thick, or the rivet large; it allows it to advance in the case of opposite conditions. The builders also make a plain bulldozer of the same general construction, but without the gap required by the riveting machine.

An Automatic Double Slide Press, built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., involves the novel construction of employing what is practically a series of eight sub-presses, through which the strip of stock is passed by a roll and ratchet feed. As the press is double acting, the variety of operations it is possible to perform is almost limitless. At 180 strokes per minute, the regular working rate, it completes that number of parts per minute, performing in the same time 1,440 operations, all of which are completed without any re-handling.

Portable Oxy-Acetylene Outfit. This outfit consists of an acetylene generator and carbon generator, mounted on a truck so that it can be taken from place to place as required by the work to be done. The acetylene is produced by lump carbide, and the oxygen by the heating of a mixture of black oxide of manganese and chlorate of potash, the heating being done by Bunsen burners fed from the acetylene tank. This apparatus has been designed to meet all fire insurance requirements, and provides for the doing of autogenous welding in a very simple and satisfactory way. The builder of the apparatus is F. C. Sanford Mfg. Co., Bridgeport, Conn.

Machine for Bending Rods or Bars. This machine, which is made by the Wallace Supply Co. of Chicago, Ill., was particularly designed for bending rods for reinforced concrete work. It is applicable, however, to all operations of this sort within its range, which is for work up to 1 inch in diameter or ½ x 4 inches, in soft stock, cold. This great power is obtained, while still making rapid handling possible on smaller work, by providing two means of operating the bending dies. For small work, the bending is done directly by hand. For heavier work, a gear and pinion connection is operated by a ratchet lever, thus giving increased power.

A New 8-inch Bench Lathe has been brought out by the Waltham Machine Works, Waltham, Mass. It involves a number of improvements in its construction, differing from the usual design of this type of lathe. One of the most noticeable of these differences is the placing of the large end of the cone pulley at the front end of the bearing, and the provision of unusually large chuck and spindle capacity. The removal of the pulley screw is all that is required to withdraw the spindle out through the front bearing. Convenient forms of slide rests are provided, together with chasing, screw cutting, grinding, milling, and other attachments.

A Hand Threading Machine, made by the Threading Machine Co., Sandusky, Ohio, has the novel feature of a positive lead screw for the chasers. The apparatus also includes a conical ring which automatically closes the chasers with the proper taper for the standard Briggs thread. An automatic throw-out is also provided which removes the chasers from contact with the pipe when the thread has been cut to the proper distance. The smaller sizes of this tool are operated by handles in a way similar to the ordinary threading die stock. The larger sizes are mounted on tripods or benches, and are geared to work by hand cranks.

A Large Portable Boring Machine, built by the Beaman & Smith Co. of Providence, R. I., is notable for its compactness and neatness of design, and for the way in which all the controlling handles have been brought within easy reach of the operator's platform. It consists of a traveling column mounted on a base-plate, and carrying a 10 H.P. variable speed motor for driving the spindle. The spindle has a power feed longitudinally, a vertical feed for the saddle on the column, and a horizontal feed for the column on the bed. Quick traverse is also provided for these movements. The column travel is 6 feet, and the vertical movement of the saddle, 4 feet 6 inches. The boring spindle is 5 inches in diameter and has eighteen speed changes.

An Enclosed Pinion Type Drill Chuck has been put on the market by the T. R. Almond Mfg. Co., Ashburnham, Mass. This is the well-known Almond type of chuck, altered to permit the use of a pinion and square end key for tightening. The body of the chuck is recessed to receive the pinion, which meshes with teeth cut in the front of the geared nut. As the pressure on the nut is at the back, the same wearing surface is preserved as in the former chuck of this make. A cap covers the pinion and provides a support for the outer end while the inner end has a bearing in the body of the chuck. Both pinion and nut are made of a special grade of tool steel, tempered. The knurled sleeve can be used for quick adjustment, as formerly, while the key is used for final tightening.

* * *

The growing scarcity of lumber in the United States makes the use of concrete for building and general construction work imperative wherever it can be employed, but a great drawback to the use of concrete in monolithic construction—the most desirable form—is the necessary use of a large amount of lumber for the forms to support the concrete during the setting period. An ingenious plan for avoiding a large part of the lumber expense and at the same time securing a superior concrete structure was employed at Camp Perry, Ohio, last summer, for the construction of a two-story mess hall. The sides of the building were molded in reinforced concrete flat on the ground. The reinforcement was steel rods interlaced into the structure in approved form so as to strengthen it around the windows and other openings. When the concrete had hardened the sides were raised to a perpendicular position and the corners were united by twisting the ends of the reinforcement rods together, and were filled out by pouring liquid cement around them. Obviously a much better concrete structure is obtained when molded flat, the material being more readily rammed into position. The labor is much reduced both as regards ramming and elevating into position. A drawback to the extensive use of this plan of erecting concrete structures is that it cannot be readily employed where buildings are close together, there being insufficient room for the side walls in horizontal position unless the buildings are separated by a distance equal to the height of the walls.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The twenty-ninth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 W. Thirty-ninth St., New York, December 1 to 4. Six professional sessions will be held, two of them simultaneously with other sessions. The opening session will take place at 8:45 P. M. December 1, when the president will address the society on the Conservation Idea as Applied to the American Society of Mechanical Engineers. After the reading of the president's address, a social gathering will follow. During the three following days professional sessions will be held, at which a great number of papers will be presented, these papers being briefly reviewed below. On the evening of December 2, Lieutenant Frank P. Lahm, of the Signal Corps of the United States Army, will deliver an illustrated lecture on aeronautics. On the evening of December 3 there will be a reception in the Engineering Societies Building, when the president and president-elect will receive members and guests in the auditorium.

REVIEW OF THE PAPERS.

The Engineer and the People, by Mr. M. L. Cooke.

This paper contains a general discussion on the duties of the engineer, as a member of his profession, toward the public. Throughout the paper various ways in which the engineer can fulfill these duties are pointed out, and special attention is given to the lines along which engineers could be particularly active in the public interest. The paper lays down a general plan for a larger measure of cooperation between engineering societies and the general public.

Aeronautics, by Major G. O. Squier.

This paper is the first presentation of the subject of aeronautics before a national engineering society in America. The author is connected with the Signal Service of the United States Army, and has, consequently, had an opportunity to observe at close range the construction, equipment and principles of operation of heavier-than-air machines, and dirigible balloons. The paper contains much valuable information, due to the fact that the material upon aviation on file in the War Department has been placed at the disposal of the author for the preparation of his paper.

A Method of Obtaining Ratios of Specific Heats of Vapors, by Mr. A. R. Dodge.

A method of obtaining ratios of specific heats which does not involve the use of available steam tables conceded to be inaccurate for such investigations, is given in this paper. The method is based upon the expansion of fluid initially superheated in a throttling calorimeter, and tables are included giving data for calculations.

The Total Heat of Saturated Steam, by Dr. H. N. Davis.

This paper contains the results of another investigation along the same lines as that outlined in the paper by Mr. A. R. Dodge, referred to above. The author reviews various experiments made, and compares the formulas by means of which the total heat of saturated steam can be determined. A new formula which differs somewhat from the classic Regnault's formula, is given, together with diagrams showing the deviation between the results obtained by the two formulas.

Fuel Economy Tests, by Mr. C. R. Weymouth.

Results of tests made at the 15,000 K. W. power plant of the Pacific Light and Power Company, Redondo, Cal., are here presented. The power plant has steam engine prime movers, crude oil being used for fuel. The results of the tests indicate a remarkable economy for all conditions, and of special interest is the almost uniform fuel economy for the plant, for all fractional loads from about one-half load up to the maximum capacity.

Unnecessary Losses in Firing Fuel Oil and an Automatic System for Eliminating Them, by Mr. C. R. Weymouth.

The author presents as a solution to the problem of automatic firing of steam boilers in plants using liquid fuel, an automatic system of regulation. The development and details of this system are explained, as well as results obtained by its practical application.

Efficiency Tests of Milling Machines and Milling Cutters, by Mr. A. L. De Leeuw.

Machine tool designers and machine tool builders, as well as mechanics in general, will be particularly interested in this paper, which has direct bearing on the performance of one of the most important machines in the modern machine shop. Besides giving interesting data regarding tests performed on milling machines and cutters, the paper gives a general outline of the logical principles followed by the machine designer in developing what might be called a scientificially designed machine. An abstract of this paper will be found elsewhere in this issue, engineering edition.

Metal-cutting Tools without Clearance, by Mr. J. Hartness.

The objects of the tool described in this paper are: the reduction of the stresses existing at the cutting point; the provision for support of the cutting point by a bearing of the face of the tool against the surface of the metal just cut, with a view of eliminating lateral vibration; and the balancing of the side pressure upon the cutter. The cutter is supported in a holder which allows it to swivel about an axis coincident with the cutting edge, thus permitting the tool to follow the cut. A cutter with an acute point is used, which produces a continuous chip, and a chip breaker is a part of the design.

Development of a High-speed Milling Cutter with Inserted Blades, by Messrs. Wilfred Lewis and W. H. Taylor.

This paper contains a review of prevailing methods of making inserted blade milling cutters, and then outlines the reasoning which led up to the design of the milling cutter described. The paper is amply illustrated, showing the details of the design; and results of experiments carried out for testing the efficiency of the cutter in actual work, are presented. One of the most prominent features of the new milling cutter is that the blade is bent to form a helix, thus permitting a definite slope and lip angle throughout the entire length of the blade, a condition which is not possible with the ordinary inserted blade milling cutter having straight blades inserted at an angle with the axis of the cutter body.

Interchangeable Involute Gear Tooth Systems, by Mr. Ralph E. Flanders.

This paper discusses the effect of changing the addendum and pressure angle of interchangeable involute gearing, from the standpoints of interference, number of teeth in continuous action, strength, efficiency, durability, smoothness of action, etc. The comparisons of various typical involute systems in regard to these points seem to the author to justify the adoption of a new or alternative standard of smaller addendum and greater pressure angle, for use in large, heavy work, and for smaller high-speed gearing as well, if experience shows that it can be used on that work without losing smoothness of action.

Spur Gearing on Heavy Railway Motor Equipments, by Mr. N. Litchfield.

This paper deals with the breakage of gearing in heavy electric railway service. A resumé is given of the methods employed to overcome the breakage, and the strains in the teeth as calculated by the Lewis formula are shown. Attention is called to the fact that this formula is not entirely applicable on account of the difficulty in maintaining alignment of gear and pinion.

Articulated Compound Locomotives, by Mr. C. J. Mellin.

The articulated compound locomotive as met with in present American locomotive practice for heavy freight service, is described, and the object and advantages of this design are briefly referred to. By means of this construction the tractive power can be doubled over that of the ordinary engine for a given weight of rail, and, at the same time, a substantial saving in fuel is obtained.

Liquid Tachometers, by Mr. A. Trowbridge.

This paper contains an illustrated description of the operation, construction and methods of testing liquid tachometers. The principle on which the liquid tachometer acts is that the pressure developed by the centrifugal force of the liquid when the instrument is running at a certain speed, is a definite quantity. Among the many applications for which liquid tachometers have been adapted the first has been for labora-

tory service in testing dynamos and engines and other machines with revolving members. Another use for these instruments has been as a speed indicator for automobile and locomotive service.

Training Workmen in Habits of Industry and Cooperation, by Mr. H. L. Gantt.

This paper deals with the old and new methods of training workmen, and maintains that if the training is based on scientific investigation, the efficiency of the workmen can be greatly increased, and employers can, as a consequence, afford to compensate those who show increased efficiency far in excess of the compensation usually paid for similar work.

Salt Manufacture, by Mr. G. E. Willcox.

This paper contains a description of the mechanical methods and engineering features of large salt plants, and reviews from the mechanical engineer's point of view, a few of the more recent developments in this manufacture. Reference is made solely to plants operated by what is known as the steam grainer system, as distinguished from the vacuum pan system and the solar or open-air system. The paper is illustrated with line diagrams and half-tone engravings and contains much of general interest.

Industrial Photography, by Mr. S. Ashton Hand.

The importance of photography in the machine industry should not be underestimated, because photography is one of the most important aids of the selling department of a machine-manufacturing plant, the photographs themselves, or, in the majority of cases, half-tones made from the photographs, being an important part of all advertising mediums. In the present paper the author describes in detail the apparatus employed and the principles considered in making photographs of industrial objects. It deals with the preparation of the subject to be photographed, the lighting and position, the focusing, the exposure, and the copying and enlarging of negatives.

Reminiscences of a Gas Engine Designer, by Mr. L. H. Nash.

In this paper the author reviews some of the steps of progress in the development of the gas engine, which have come within his personal observation. He describes different types of engines, including the two-cycle engine, and several devices of general interest invented by himself. One of these is a sewing machine motor which failed of commercial success because of the lack of mechanical appreciation of the feminine operator of this machine.

Some Possibilities of the Gasoline Turbine, by Mr. F. C. Wagner.

In considering the possibilities of a gas turbine, it is commonly assumed that the gas should be burned with something near the theoretical quantity of air required for complete combustion, the same as is done in the expansion gas engine of the ordinary type. The temperatures produced by the combustion of the gas, however, are so high that the strength of the metal wheel is seriously diminished. It is the purpose of the present paper to compare different methods for reducing the temperature of the gases, and especially to consider how such a reduction affects the efficiency of the turbine and air compressor. The paper contains considerable data which will interest gas and gasoline engine designers.

Physical Properties of Carbonic Acid and Conditions of its Economic Storage for Transportation, by Prof. Reid T. Stewart.

A number of tables and charts accompanying this paper show, in condensed form, the results of recent investigations made regarding the physical properties of carbonic acid. The value of these investigations is that they furnish the data necessary in investigating the strength and safety of existing carbonic acid cylinders, and in the designing of new cylinders on a safe and economic basis. The methods employed in carrying out the scientific investigations are reviewed, and the latter part of the paper refers directly to the design of carbonic acid cylinders, giving formulas relating to their calculation and proportioning.

The Slipping Point of Rolled Boiler Tube Joints, by Prof. O. P. Hood and Prof. G. L. Christensen.

The object of this paper is to supply data regarding the behavior of joints made by the familiar method of rolling boiler tubes into containing holes. Diagrams are presented showing the loads required to pull tubes from their seats, and results of tests with cold drawn boiler tubes rolled into various forms of tube openings, are given. The method of applying the load and measuring the slip is also illustrated and described.

Tests of Friction Clutches for Power Transmission, by Prof. R. G. Dukes.

This paper gives the results of tests on friction clutch couplings for determining their maximum capacity. Five examples of the best-known types of clutches were purchased in the open market, and all were tested under similar conditions. Each clutch was subjected to a series of cone pressures, gradually increasing in amount, the maximum load which the clutches would pick up and carry being determined for each cone pressure.

An Averaging Instrument for Polar Diagrams, by Mr. W. F. Durand.

This paper has been prepared with the intention of describing an instrument for obtaining averages for diagrams, plotted in polar coordinate. While this paper is chiefly of theoretical interest, engineers interested in dial-recording gage instruments which trace diagrams in polar coordinates, but with a curvilinear path of the tracing arm, will undoubtedly find the instrument described, of interest.

* * *

The matter of supplying machines with lubricating fluid may be decided either in favor of a distributing system of pipes supplied from a common reservoir by one pump, or by making each machine a unit in itself, having its own reservoir and pump. Both systems have certain advantages and disadvantages. If a central distributing system is installed, it is the same as "putting all your eggs in one basket"; if anything goes wrong with the piping or pump, a whole department is held up until the trouble is remedied. Again, there is the difficulty of carrying the supply and return pipes through the shop to every machine, without causing obstructions and a generally hideous mess. If the shop construction is such that the supply for one floor can be distributed underneath the floor and up to each machine through the floor beneath it, there is little objection to the distribution plan, but this plan is not always feasible. Serious troubles frequently arise from clogging of the pipes by deposits adhering until a pipe is completely filled. These difficulties are avoided by the unit system in which each machine has its own supply system. The individual system means a reservoir and pump for each machine, and instead of one pump occasionally giving trouble you may have a hundred in the course of a year. The individual reservoirs may add to the floor space required, and keeping up the supply means carrying in fresh lubricant in pails. These features are somewhat objectionable, but balancing one system against the other, Mr. McGregor, of the Union Twist Drill Co., Athol, Mass., found from personal experience that the individual system is incomparably better, and it was adopted for the twist drill fluting machines in the drill department of his company. The installation is satisfactory in all respects. The general appearance of a department fitted thus is superior to that of one having the common distributing system. The secret of success is getting pumps that are reliable, and providing strainers that strain.

* * *

The paper "High Powered Rifle and Its Ammunition" presented by Mr. Franklin Phillips at the monthly meeting of the American Society of Mechanical Engineers, November 10, was attended by a good audience of interested members. The paper was illustrated with numerous lantern slides, and many technical points in regard to the construction and use of military rifles were brought out. Captain Phillips is an expert rifle shot and spoke with much enthusiasm on the need of teaching the art of rifle shooting to young men. Captain Casey of the U. S. Army followed with a few remarks in regard to the development of the Spitzer bullet, and spoke of the change from 150-grain bullets to 180-grain bullets, made necessary by the irregularities due to windage with the lighter bullet. He was followed by Captain Waldron of the Ross Rifle Co., Mon-

treal, Canada. Captain Waldron illustrated on the screen a new cartridge developed for the Ross rifle, which gives the extraordinary initial velocity of 3,000 to 3,100 feet per second. A piece of steel plate ⅝ inch thick, 40 carbon steel, was exhibited which had been penetrated at a distance of 40 to 50 yards. Some one remarked, after the meeting, that with such guns "Mother's Bible" would not be of much service in protecting her son from the bullets of the enemy.

* * *

In the description of the handy center indicating tool by W. W. Cowles in the November issue it is stated that the ball in which the point is mounted is hardened. This is not necessary and, in fact, the ball is preferably left in the annealed condition necessary for drilling the hole. It was also intimated that the spindle of the machine must be stopped in order to use the tool. This is unnecessary as the indicator can be used without stopping the machine by simply guiding the pointer to the prick-punch mark with the finger and then withdrawing the work. The pointer will then run "out" if the center mark is not dead in line with the spindle.

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PERSONAL.

William E. Keily has resigned his position as managing editor of the *Western Electrician*, and will act as a general writer on technical and commercial subjects.

Walter B. Snow, publicity engineer, Boston, Mass., has been appointed by Governor Guild, a member of the Massachusetts Commission for the Blind.

Hugh A. Brown has resigned his position in the Chicago office of the Crocker-Wheeler Co. to become sales manager for the Rockaway Coaster Co., Cincinnati, Ohio.

James A. Pratt who for the past two years has held a position as instructor in machine work at Pratt Institute, Brooklyn, N. Y., has been appointed to a similar position at Williamson Free School of Trades, Delaware County, Pa.

J. R. Gordon has been appointed manager of power apparatus sales for the Western Electric Co. in its Southern territory. Mr. Gordon is well known throughout the country as a pioneer in the electrical field, having been associated with those who organized and operated the first Edison plants. His headquarters will be in Atlanta, Ga.

F. W. A. Joly, president of the Association of German Manufacturers of Fire-brick (Wirtschaftliche Vereinigung Deutscher Chamotte Fabrikanten), is on a visit to America to study American conditions with a view of drawing therefrom applications for the fire-brick industry in Germany. The association of which he is president has established standards of quality and shape, reducing the number of shapes materially; it has studied the requirements of customers with reference to tensile strength, refractory qualities and uniformity of product. American fire-brick makers may obtain valuable suggestions from the experiences of German makers. Mr. Joly is making the Hotel Astor, New York, his headquarters.

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OBITUARY.

Prof. William Edward Ayrton, a noted electrical engineer and inventor, died in London, November 8, aged sixty-one.

Cyrus C. Currier, of Cyrus Currier & Sons, Newark, N. J., died October 30 at his home in South Orange, N. J., aged sixty-one.

General John E. Mulford, founder and for thirty-one years president of the Prentiss Vise Co., died at his home in Montour Falls, New York, October 18, aged seventy-nine years.

Herbert D. Hale, architect of the Engineering Societies Building, New York, died at his home in New York, November 10, aged forty-two years.

Frank B. Kleinhans, chief draftsman of the United Engineering Co., Pittsburg, Pa., died in Easton, Pa., aged 34. Mr. Kleinhans was the author of the book "Boiler Construction," and a contributor to MACHINERY and other trade journals.

Alfred Marsh, a geologist and chemist, and inventor of the gas meter in common use, died November 17 at Kalamazoo, Mich., aged ninety years. Mr. Marsh was born in England and for many years was employed by the Manhattan Gas Co., New York.

William Eddy Ripley, one of the oldest and most esteemed employes of the Brown & Sharpe Mfg. Co., Providence, R. I., died November 10 at his home in that city, aged sixty-five years. Mr. Ripley was connected with the Brown & Sharpe Co. for almost all his active business life, having entered the employ of the company in 1864. Up to 1902 he was timekeeper in charge of the cost-keeping department, and since has filled the responsible position of confidential secretary. Mr. Ripley was a member of the local societies, clubs and lodges, and is survived by a widow and a son and daughter.

Samuel D. V. Burr died at his home in Plainfield, N. J., October 28, aged fifty-three. He was born in New York and moved to Plainfield when a boy, where he graduated from the Plainfield High School in 1870. Later he graduated from Rutgers College, and became a writer on engineering and scientific subjects. Mr. Burr was on the staff of the *Scientific American* for six years, the *Engineering News* for three years, and the *Iron Age* for sixteen years. He was the author of "Bicycle Repairs," "Tunneling Under the Hudson," "Rapid Transit in New York and Other Great Cities." He is survived by his wife, son and daughter.

George A. Fairfield, secretary of the Hartford Board of Trade and one of the best known business men of the city, died suddenly November 9, aged seventy-four. He was apprenticed at seventeen in the machine shop of Lucius and Ira Dimmock, Northampton, Mass., makers of silk machinery. Following his apprenticeship, he worked for several concerns, and at the breaking out of the Crimean War, was with Robins & Lawrence, Windsor, Vt., who had contracts for making guns for Great Britain. When this work was completed he went with the American Machine Works at Springfield, Mass., where he designed most of the labor-saving machinery in the U. S. Government Armory in that city. In 1857 he was employed by Colt's Patent Fire-arms Mfg. Co. of Hartford, where he worked on a contract with the Russian Government to furnish it with machinery for manufacturing fire-arms. Mr. Fairfield opened the first purely mechanical drawing school in Hartford in 1858. In 1865 he entered the employ of the Weed Sewing Machine Co. and built it up into a great enterprise. Later he was associated with Colonel Albert Pope in the manufacture of bicycles and was influential in bringing the great industry to Hartford. Mr. Christopher M. Spencer interested Mr. Fairfield in the manufacture of the Spencer repeating rifle, and it was for some time manufactured in the Weed Sewing Machine factory. Mr. Fairfield was director in a number of the important industrial and commercial concerns in Hartford.

Elmer G. Eberhardt of Newark, N. J., vice-president of the Newark Gear Cutting Machine Co., died November 21, 1908, of tuberculosis, after an illness of less than a year. He was born in Newark, 1881, and attended the public schools there. He was graduated from the Newark High School in 1896 at the age of fifteen years, and from there entered Stevens Institute at Hoboken, N. J. He was soon at the head of his class, but decided, in his second year, to take up the practical work of machine tool designing and construction, and therefore discontinued his course to engage in work with his father, Henry E. Eberhardt. After several years of this work, during which he made a number of improvements and inventions, especially relating to automatic gear-cutting machines and crank shapers, he decided to finish his technical education. He accordingly entered Sibley College of Cornell University in the middle of the school year of 1900-1901, and graduated in 1904 with the degree of mechanical engineer.

While at Cornell he acquired the nickname of the "General" because of his acknowledged leadership in the classes of mathematics, mechanics, and engineering. He was elected president of the Cornell Institute of Electrical Engineers and

Elmer G. Eberhardt.

vice-president of the Cornell Society of Mechanical Engineers. At the close of his course he was awarded the honorary key of the Sigma Xi for high scholarship in the engineering studies. Besides his studies, he was actively interested in athletics.

Upon graduation, Mr. Eberhardt entered into the machine tool manufacturing business, forming with his father and three brothers, the Eberhardt Brothers Machine Company, which is now the Newark Gear Cutting Machine Company. He was made the vice-president, and from the beginning of the business, until his illness necessitated his leaving the work which he loved, he was active in the designing and construction of the gear-cutting machines and crank shapers made by the firm. He took out a number of patents upon inventions covering many branches of the machine field.

Mr. Eberhardt had been a contributor to MACHINERY ever since its beginning, and he many times expressed himself as much interested in the problems which appeared from time to time in its columns. He had a wide reputation as a consulting engineer upon matters especially relating to gears and gear-cutting, and engaged in original investigations along this line. He was an associate member of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers.

Mr. Eberhardt is survived by his parents, one sister and four brothers, three of whom are engaged in the business. He was beloved by all who knew him, and especially in the factory was he liked, by the apprentices and others who looked up to him as a teacher with experience.

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COMING EVENTS.

December 1-4.—Annual convention of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York City. C. W. Rice, 29 West 39th St., New York, secretary.

December 7-10.—Annual convention of the National Commercial Gas Association, First Regiment Armory, Michigan Ave. and 16th St., Chicago, Ill. Coincident with the meeting, and throughout the week, the association will hold its annual exhibition of gas appliances. John C. D. Clark, 157 Michigan Ave., Chicago, chairman of the committee of arrangements.

December 9.—Mr. M. A. Loeb, secretary and treasurer of the Rock Island Battery Co., Rock Island, Ill., has issued a call to the manufacturers and dealers of gas and gasoline engines, and dealers and manufacturers of accessories thereto, to attend a preliminary meeting at the Auditorium Hotel, Chicago, December 9, 1908, 10 A. M., with a view of discussing and formulating plans for the formation of an association. Officers are to be elected and a committee appointed for the purpose of arranging for a national convention to be held at some time and place decided upon by the executive committee.

December 11.—Meeting of the American Institute of Electrical Engineers at 33 West 39th St., New York City, 8 P. M. R. W. Pope, secretary.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York.

NEW BOOKS AND PAMPHLETS.

THE LUMBER CUT OF THE UNITED STATES, 1907. 53 pages, 6 x 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

Charities and the Commons is a weekly journal of philanthropy and social advance issued by the Charity Organization Society of the City of New York, publication office 105 East 22d St., which will be found of value to all interested in social welfare work. The price is $2.00 per year, single copies 25 cents.

THE TEMPERATURE-ENTROPY DIAGRAM. By Charles W. Berry. 299 pages, 5 x 7¼ inches. 109 figures. Published by John Wiley & Sons, New York. Price $2.00.

This is the second edition of a volume first brought out in 1905, and intended especially for the use of students of thermodynamics. The present edition is considerably enlarged, it being more than doubled in size. A more extended application of the principles of the $T\phi$-analysis to advanced problems of thermo-dynamics has been made, the chapter on the Flow of Fluids has been entirely re-written, and various other phases of the subject in hand have been more thoroughly discussed.

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1909. 208 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., Manchester, England. Price 6d. net.

This convenient and useful handbook contains considerable matter of value to electricians and others interested in the electrical industries, dynamos, and motors. Some of the different sections are headed: Electrical Units, Electrolysis, Magnets, Electric Bells, Power Transmission, Dynamos and Motors, Alternate Current Systems, Rotary Converters, Care of Dynamos and Motors, Line Wires and Conductors. Many useful tables are included, and blank pages for diary and memoranda conclude the book.

AUDEL'S GAS ENGINE MANUAL. 469 pages, 5¼ x 8¼ inches. Published by Theo. Audel & Co., New York. Price $2.00.

This book is a practical treatise relating to the theory and operation of gas, gasoline, and oil engines, and includes chapters on producer gas plants, marine motors, and automobile engines. It contains a great deal of useful information relating to the care of combustion engines. Some of the most interesting chapters are: Theoretical Working Principles; Indicator Diagrams of Engine Cycles; Fuels and Explosive Mixtures; Gas Producer Systems; Compression, Ignition and Combustion; Governing and Governors; Ignition and Igniters; Installation and Operation; Oil Engines; Testing; Nature and Uses of Lubricants.

PATENTS AS A FACTOR IN MANUFACTURING. By E. J. Prindle. 134 pages, 5 x 7½ inches. Published by The Engineering Magazine, New York. Price $2.00.

The purpose of this volume, according to the author, is not to make the inventor and manufacturer his own patent lawyer, but it is intended to convey general ideas regarding the nature of patents, the protection they may afford, the relation of employers and employees to patents, and the general rules by which the courts will proceed in upholding a patent and in thwarting attempted infringement. It is intended especially to lay down fundamental principles, in order to enable the inventor or manufacturer to take the early steps which are usually taken before the advice of counsel is secured.

THE MECHANICAL ENGINEERING OF STEAM POWER PLANTS. By F. R. Hutton. 825 pages, 6 x 9 inches. 700 figures. Published by John Wiley & Sons, New York. Price $5.00.

This is the third, re-written, edition of Professor Hutton's well-known work on steam power plants. The new treatments in the present edition which are specially noteworthy are those of the analysis of the power plant, and the distinction between the simple and the complex phases of this problem; the treatment of the steam pipe as an element of co-ordinate importance with the boiler and engine; the chapters on auxiliaries; the chapter on steam turbines; and on the engine mechanism. These new sections add considerably to the value of the book, and will prove interesting to power-plant engineers and others concerned with the subject, in its engineering aspect.

MACHINE SHOP CALCULATIONS. By Fred H. Colvin. 174 pages, 4½ x 7 inches. Published by the Hill Publishing Co., New York. Price $1.00.

In the preface of this book the author states that while the treatment of the subject may be considered too elementary by some, he has tried to make every point so clear that anyone can comprehend it, and to show how the methods apply to every-day shop work. The different chapters in the book are headed as follows: Common Fractions; Decimal Fractions; Cancellation; Ratio or Proportion; Percentage; Speed of Pulleys; Speed of Gearing; Gearing a Lathe to Cut Any Thread; Screw Thread Calculations; Drilling for Taps; Taper Work; Speed of Lathes, Planers and Shapers; Square and Cube Root; Measuring Surfaces; Contents or Volume of Solid Bodies; Measuring Angles; Making and Using Formulas; The Vernier and Micrometer; Regular Polygons and Their Properties; The Uses of Shop Trigonometry; Trigonometry Tables.

RAILROAD ENGINEERING. By W. L. Webb. 296 pages, 6½ x 9½ inches. 161 figures, 23 tables. Published by the American School of Correspondence, Chicago, Ill. Price $3.00.

This book is divided into three sections, each dealing with a different phase of railroad engineering. The first section is devoted to railroad surveys, dealing with surveying methods and instruments and railroad location. The second, and by far the largest, section is devoted to construction, operation, and maintenance, and the third to the economics of railroad management; this latter part, of course, deals with this subject from the engineer's point of view. The volume is especially adapted for purposes of self-instruction and home study, and care has been taken to keep the treatment of each subject within the range of the student's understanding, so that the work appeals not only to the technically trained expert, but also to the self-taught practical man who wishes to keep abreast of modern progress. Of course elementary mathematical foundation is required in order to be able to follow the developments of the formulas and the methods explained.

CATALOGUES AND CIRCULARS.

PATTERSON TOOL & SUPPLY CO., Dayton, Ohio. Leaflets of the Owen milling machines built in three sizes.

PRATT & WHITNEY CO., Hartford, Conn. Miniature catalogue of Pratt & Whitney turret lathes, which are built in five sizes.

WEBER GAS ENGINE CO., Kansas City, Mo. Catalogue of Weber gas engines and gas producers.

SKINNER CHUCK CO., 94 N. Stanley St., New Britain, Conn. Circular of the 1904 pattern independent Skinner lathe chuck.

S. OBERMAYER CO., Cincinnati, Ohio. Catalogue No. 40 containing 369 pages devoted to foundry supplies and information for the foundryman.

NATIONAL SEPARATOR & MACHINE CO., Boston, Mass. Circulars descriptive of cylinder turret drill presses, and combined oil separator and filter.

REEVES ENGINEERING CO., Mt. Vernon, Ohio. Catalogue of Reeves vertical internal combustion engines for gas, gasoline and distillate fuels.

AMERICAN SPIRAL PIPE WORKS, P. O. Box 485, Chicago, Ill. Catalogue of spiral riveted pipe, forged steel pipe flanges, hydraulic and exhaust steam supplies.

VICTOR R. BROWNING & CO., Cleveland, Ohio. Bulletins Nos. 2 and 3, illustrating overhead electric traveling cranes and Armington electric hoists, which are made in several styles.

BRASS FOUNDERS SUPPLY CO., Newark, N. J. Catalogue No. 14 of flasks and other equipment and supplies for modern brass, bronze aluminum and iron and steel foundries.